

## **APPENDIX B**

### **EMISSIONS MODELING FOR THE HGB ATTAINMENT DEMONSTRATION SIP REVISION FOR THE 2008 EIGHT- HOUR OZONE STANDARD**

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# **APPENDIX B: EMISSIONS MODELING FOR THE HGB ATTAINMENT DEMONSTRATION SIP REVISION FOR THE 2008 EIGHT-HOUR OZONE STANDARD**

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## CHAPTER 1: GENERAL MODELING EMISSIONS DEVELOPMENT

The EPA's [\*Draft Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM<sub>2.5</sub>, and Regional Haze\*](#) (EPA, 2014b), specifies a procedure for demonstrating attainment through modeling. Instead of using the model results in an absolute sense, the eight-hour ozone procedure uses the modeling results in a relative sense. This relative approach is based on how the model responds to the change in emissions between a baseline and a future year. Therefore, the photochemical modeling process for attainment demonstration requires four modeling emissions data sets:

- base case emissions;
- baseline emissions;
- future year emissions; and

### 1.1 BASE CASE MODELING EMISSIONS

In order for the photochemical model to be used in the attainment demonstration, the model needs to be capable of adequately replicating historical episodes (base cases) for which high eight-hour ozone was measured. To maximize model performance, base case emission inputs are estimated as accurately as possible. In the development of the base case modeling emissions, a number of quality assurance techniques are used to evaluate the reasonableness of the emission magnitudes, along with their spatial distribution and temporal profile. Using the quality assured episode-specific emissions along with other modeling inputs (e.g., meteorology), the photochemical model is run and the simulated concentrations of both ozone and ozone precursors of nitrogen oxides (NO<sub>x</sub>) and volatile organic compounds (VOC) are compared to the measured concentrations to evaluate the adequacy of the photochemical model in replicating the base case. If the evaluation indicates that the base case is not adequately replicated, then diagnostics are conducted to determine which modeling inputs are unsatisfactory. When the emissions are implicated, the modeling emissions are reviewed and pertinent revisions are made. If the evaluation implicated other inputs, or once the photochemical model adequately replicates the base case, then the modeling emissions are considered to be representative of the episode.

A summary of the primary data sources for the development of the base case modeling emissions is provided in Table 1-1: *Summary of Base Case Point Source Emission Data Sources*, Table 1-2: *Summary of Base Case On-Road Mobile Source Emission Data Sources*, and Table 1-3: *Summary of Base Case Non-Road Mobile, Area, Oil and Gas, and Biogenic Source Emission Data Sources*.

**Table 1-1: Summary of Base Case Point Source Emission Data Sources**

Region	Data Source
Texas	2012 State of Texas Air Reporting System (STARS)
Regional	2011 National Emissions Inventory (NEI) v6.2 based EPA Modeling Platform
All States	2012 EPA Clean Air Markets Division (CAMD) Air Markets Program Data (AMPD) hourly data
Offshore	2011 Bureau of Ocean Energy Management (BOEM) Gulf-Wide Emission Inventory (GWEI) platforms of western Gulf of Mexico

Mexico	2012 Interpolation from EPA's Modeling Platform
Canada	2010 Canadian EI from EPA's 2011 Modeling Platform

**Table 1-2: Summary of Base Case On-Road Mobile Source Emission Data Sources**

Region	Data Source
HGB	2012 based on MOVES2014 emission rates and Highway Performance Monitoring System (HPMS) for vehicle miles traveled (VMT) activity estimates.
Other Texas	2012 based on MOVES2014 emission rates and HPMS for VMT activity estimates.
Outside Texas	2012 based on MOVES2014 July default runs.

**Table 1-3: Summary of Base Case Non-Road Mobile, Area, Oil and Gas, and Biogenic Source Emission Data Sources**

Region	Non-Road Mobile Sources	Area Sources	Oil and Gas Sources	Biogenics
Texas	2012 run of Texas NONROAD (TexN) model	2011 Texas Air Emissions Repository TexAER	Texas Railroad Commission data and equipment-specific emission rates.	Biogenic Emission Inventory System (BEIS) 3.61
Outside Texas	2012 run of National Mobile Inventory Model (NMIM)	2011 EPA NEI	2011 EPA NEI	BEIS 3.61

Emissions modeling uses a hierarchical approach, such that the closer the area is to the nonattainment area of interest, the more detailed the resolution of the emissions. For example, Canadian emissions are expected to have very little influence on model performance in Texas, so the TCEQ does not attempt to gather hourly power plant emissions from Canada. Emissions are developed for ozone precursors of NO<sub>x</sub>, VOC, and carbon monoxide (CO), although CO is a minimal contributor in the production of ozone. The emission inventories (EIs) are prepared for photochemical modeling input using Version 3 of the Emissions Processing System (EPS3).

## 1.2 BASELINE MODELING EMISSIONS

The EPA procedure for demonstrating attainment requires the development of modeling emissions for a baseline year to be used with similarly developed future year emissions. In order to keep the baseline and future year modeling emissions commensurate, more generic non-episodic ozone season day (OSD) emissions are developed for the baseline year. The OSD modeling emissions for the baseline and future years are developed using the same averaging and estimating procedures, which provides an appropriate basis for assessing the photochemical model response to emission changes.

The major difference between the base case and baseline modeling emissions is the treatment of the hourly-specific emissions for elevated point sources, such as electric generating units (EGUs). Emissions for the other source categories are identical between the base cases and baseline modeling emissions. 2012 was chosen as the

baseline year and Section 2.2 describes the averaging processes used in the development of the baseline inventory.

### 1.3 FUTURE YEAR MODELING EMISSIONS

The eight-county HGB area is classified as moderate nonattainment under the 2008 eight-hour ozone standard. The attainment date for HGB is July 20, 2018, with a 2017 attainment year. In general, 2017 future year emissions were estimated by applying growth projections and accounting for existing federal, state, and local controls on the baseline (in most cases) emissions. The 2017 modeling emissions include the benefits of the Federal Tier 3 Vehicle Emission and Fuel Standards Program, the Mass Emissions Cap-and-Trade (MECT) Program in the HGB area, the Highly Reactive VOC Emission Cap-and-Trade (HECT) Program in Harris County, and the EPA's Cross-State Air Pollution Rule (CSAPR).

### 1.4 FUTURE YEAR CONTROL STRATEGY AND/OR SENSITIVITY ANALYSES EMISSIONS

For the current Attainment Demonstration (AD) State Implementation Plan (SIP) revision, a sensitivity modeling run was performed to determine the impact of potential (reductions that have already occurred but have not yet been certified) Emissions Reduction Credits (ERCs) on the future design value. In addition to the certified ERCs extracted from the Emissions Banking and Trading Credit Registry, an additional 1,317.4 tons per year (tpy) of NO<sub>x</sub> and 2,851.6 tpy of VOC reductions were incorporated into the future emissions. The inclusion of these potential ERCs resulted in a future design value increase of 0.09 ppb at the Manvel Croix Park (C84) monitor. The overall maximum impact was an increase of 0.15 ppb at the Clinton monitor. Details of this sensitivity modeling run are provided in Section 2.7.1 of this appendix.

## CHAPTER 2: POINT SOURCE MODELING EMISSIONS DEVELOPMENT

Point source emissions development began with the emission inventory from the July 2016 DFW AD SIP Revision for the 2008 Eight-Hour Ozone Standard. Point source emissions were developed for the May 1 through September 30, 2012 modeling period. The data sources for development of the point source modeling emissions are summarized in Table 2-1: *Sources of Point Source Emissions Data*. The data was compiled and formatted to generate modeling datasets for the base case, the baseline, and the future case studies as detailed in subsequent sections.

**Table 2-1: Sources of Point Source Emissions Data**

Sources of Data	Calendar Year(s) Used
TCEQ STARS	2012, 2014
TCEQ MECT Allocations for sources in HGB	2017
TCEQ HECT Allocations for sources in Harris County	2017
EPA CAMD AMPD of power plant Continuous Emissions Monitors (CEMs) for all states	2012, 2015
EPA CSAPR allocations for entire modeling domain	2017
Electric Reliability Council of Texas (ERCOT) Capacity, Demand, and Reserve report	2017
TCEQ Air Permits for proposed EGUs	2017

Sources of Data	Calendar Year(s) Used
U.S. Department of the Interior, BOEM GWEI of Offshore Platforms	2011
EPA Emissions Modeling Clearinghouse (EMCH) Modeling Platforms for NEI data	2011, 2017
Canadian EI from EPA's 2011 Modeling Platform	2010
Mexican NEI and future case projection from EPA's 2011 Modeling Platform	2008, 2018

## 2.1 2012 BASE CASE POINT SOURCE MODELING EMISSIONS DEVELOPMENT

The following sections describe development of the base case point source modeling emissions for all portions of the domain used for May through September 2012.

### 2.1.1 Texas Point Sources

Emissions modeling data files for the 2012 base case for Texas EGUs (power plants) were extracted from EPA's AMPD, and the Texas non-EGUs were extracted from the TCEQ's STARS database. The following subsections describe the development of point source modeling emissions for each of the components.

#### 2.1.1.1 State of Texas Air Reporting System (STARS)

Point source emissions and industrial process operating data are collected annually from sites that meet the reporting requirements of 30 Texas Administrative Code (TAC) §101.10. Subject entities, approximately 2000, are required to report emissions annually from all sources and emissions exhaust points with representative calculations of emission estimates. Descriptive information is also required on process equipment, including operating schedules, emission control devices, abatement device control efficiencies, and emission point discharge parameters such as location, height, diameter, temperature, and exhaust gas flow rate. All data submitted in the annual Emissions Inventory questionnaires (EIQs) are subjected to TCEQ quality assurance (QA) procedures. The data are then stored in the STARS database. The TCEQ reports point source emissions data to the EPA for inclusion in the National Emissions Inventory (NEI). The reporting requirements, guidance documents, trends, and summaries of the most recently quality assured year of reported data can be found on the TCEQ [Point Source Emissions Inventory](http://www.tceq.texas.gov/implementation/air/industei/psei/psei.html) website at <http://www.tceq.texas.gov/implementation/air/industei/psei/psei.html>.

Development of the Texas point source emission modeling files began with queries of the quality-assured data of the STARS database. Updated modeling query reports are typically run when significant STARS updates are completed. The STARS modeling extract report ("STARS") is a snapshot of Texas emissions, since regulated entities can update their information at any time.

SAS computer programming code was used to parse the STARS extract, perform various logical checks and comparisons, assign defaults for missing data, apply rule effectiveness to VOC emissions paths with control devices, and format the data into an AIRS Facility Subsystem (AFS) file that can be processed with the modules of Version 3 of the Emissions Processor System.

The STARS extract contains four types of emission rates: annual, OSD, emission events (EE), and scheduled maintenance startup and shutdown (SMSS). When supplied, the OSD emissions in tons per day (tpd) are modeled, plus any EE/SMSS for the source (after conversion to tpd). When OSD is not provided by the source, an OSD is computed from the reported summer use percentage, operational parameters, and any EE/SMSS reported. The modeled OSD emission rate is representative of average daily emissions during the summer, when monitored ozone concentrations are typically highest. An example of STARS extract data is available in Section 2.1.1 of Appendix B of the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision.

#### 2.1.1.2 Rule Effectiveness (RE)

The TCEQ applies RE to the STARS VOC emissions where relevant. The purpose is to account for the possibility that not all facilities covered by a rule are in compliance 100% of the time and that control equipment does not always operate at its assumed control efficiency. Additional details about rule effectiveness and how it is applied are described on Page B-17 of Appendix B from the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision. Applying RE to the 2012 point sources adds approximately 31% more VOC to HGB and approximately 21% more to the statewide VOC, as compared to the 2012 reported (STARS) VOC total emissions.

#### 2.1.1.3 Preparation of AFS File for EPS3 Input

The resultant OSD AFS file is in a format ready for input to EPS3. The STARS-derived AFS file for all criteria pollutants typically has more than 200,000 records. Each point source emissions path contains references for the TCEQ account (RN), equipment (FIN), and exhaust point (EPN). For ozone modeling purposes, values for the ozone precursors of NO<sub>x</sub>, VOC, and CO are retained in the AFS file for EPS3 input. The AFS file format used by the TCEQ, including expanded field descriptions and options, can be found on the [TCEQ FTP modeling](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/point/basecase/AFS/AFS-EPS3-v3.docx) webpage, [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/point/basecase/AFS/AFS-EPS3-v3.docx](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/point/basecase/AFS/AFS-EPS3-v3.docx).

#### 2.1.1.4 Preparation of Photochemical Model-Ready Files with EPS3

EPS3 is used to process the emissions in the AFS file into a format ready for photochemical model input. Photochemical model inputs require that the emissions be (in EPS3 order performed by the TCEQ):

- chemically speciated into groups of compounds with similar reactivity for the formation of ozone;
- temporally allocated by hour of day, day of week, etc.; and
- spatially allocated to grid cells or assigned to fixed three-dimensional locations.

The *EPS3 User's Guide* provides additional details for processing the point source emissions for photochemical model input (Ramboll Environ, 2015). The remainder of this section discusses some of the specific point source emissions processing procedures.

#### *Chemical Speciation with EPS3*

VOC emissions in STARS can be reported as individual compounds, mixtures, classes of compounds, total VOC, and unclassified VOC. The VOC values that are included in



the AFS file are speciated into carbon bond groups for the specific chemical mechanism of the photochemical model. The TCEQ used the sixth generation Carbon Bond (CB6) chemical mechanism, which is implemented via the EPS3 module SPCEMS (Speciate Emissions) (Yarwood et al, 2010).

The majority of TCEQ EIQ responses include constituent VOC emission rates, which are used to develop point-specific speciation profiles. When the composition of the VOC reported for a specific source is unknown or not fully-speciated, the default speciation profile is applied based on the source classification code (SCC) and the default speciation from EPA's SPECIATE database software program (EPA, 2014b). More detail on the TCEQ source-specific speciation approach is available in an international emission inventory conference paper (Thomas, 2008).

Ethane and acetone, which are technically not VOCs by the EPA's definition, are also extracted from STARS and processed in the emissions model, and are subjected to the same speciation as all of the other STARS compounds. Ethane and acetone are now included in VOC totals in tables and tile plots in subsections below because the photochemical model can use these compounds as CB6 lumped species categories of their own, along with all the other VOC species. Because ethane and acetone are additive to the VOC, the modeled and tabulated VOC will almost always be greater than reported (STARS) VOC.

#### *Temporal Allocation with EPS3*

Even though OSD is typically used for processing of photochemical modeling emissions, EPS3 can temporally distribute emissions by month, day of the week, and hour of a specific episode when sufficient detail is provided by the regulated entity in its EIQ. Previous AD SIP revision documentation provides detail about temporal allocation, along with examples of the cross reference and profile records.

#### *Spatial Allocation with EPS3*

Photochemical models generally rely on a three-dimensional Eulerian system in which emissions are allocated to individual grid cells. Emissions occur at or near the surface for most source categories such as area, biogenic, on-road mobile, and non-road mobile. These near-surface emissions are classified as low-level emissions and are released at the same time and mixed throughout the grid cell. Numerous point sources also fall into the low-level source category, but tall stacks such as large combustion sources, e.g., power plants, are categorized as elevated sources because their hot exhaust gases can rise several hundred meters into the atmosphere.

Low-level point sources are allocated to grid cells and merged with the other low-level source categories prior to photochemical model input, whereas elevated point sources are kept at their reported X-Y locations and assumed to emit from the calculated effective plume height (above the reported stack height) of Z to better simulate physical mixing in the elevated layers of the photochemical model. EPS3 processing of point source emissions is divided into low-level and elevated streams, which provides better simulation of how elevated emissions are distributed prior to mixing and reacting with surface emissions. The drawbacks of using the dual regimes are more complicated EPS3 processing and longer photochemical model run times.

The photochemical model inputs for point sources consist of a single low-level gridded merged file and a single file of elevated sources. A plume cutoff height of 30 meters was chosen to divide the point sources into low-level and elevated categories, which essentially matches the 34-meter height of the first CAMx model layer. The emissions from elevated sources can be individually tracked, and NO<sub>x</sub> reaction chemistry can be enhanced by treating these plumes as Lagrangian puffs by use of the optional Plume-in-Grid (PiG) treatment within CAMx. The Greatly Reduced Execution and Simplified Dynamics (GREASD) PiG option was used in CAMx, which is most applicable to large NO<sub>x</sub> plumes (Ramboll Environ, 2016). More detail on the GREASD PiG approach is provided below in Section 2.1.3.

Figure 2-1: *Tile Plot of HGB Eight-County OSD Non-EGU Low-Level NO<sub>x</sub> Emissions for a Day in 2012* is a tile plot of the gridded low-level OSD (non-EGU) NO<sub>x</sub> emissions for the HGB eight-county area at the 4 km grid cell resolution. Each modeled day of OSD emissions is identical, an average day during the ozone season.

Figure 2-2: *Tile Plot of HGB Eight-County OSD Non-EGU Elevated NO<sub>x</sub> Emissions for a Day in 2012* is a plot of the elevated OSD (non-EGU) NO<sub>x</sub> emissions for the HGB eight-county area. The vast majority of the NO<sub>x</sub> emissions are from elevated sources (mainly combustion sources with hot exit gas and taller stacks). The diurnal profiles of the OSD sources are generally flat (do not vary across the day), indicating that the non-EGUs are dominated by sources that operate continuously.

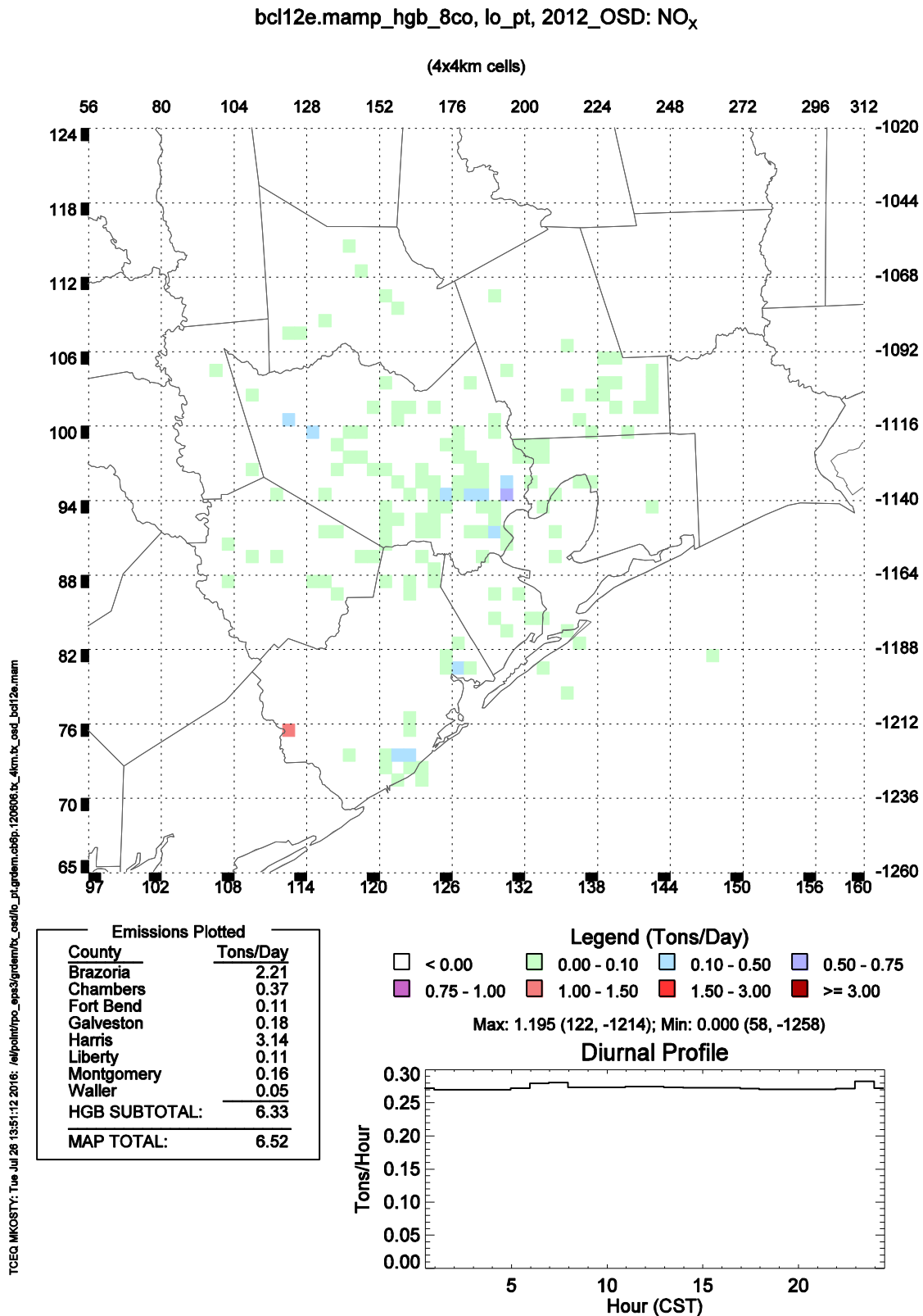


Figure 2-1: Tile Plot of HGB Eight-County OSD Non-EGU Low-Level NO<sub>x</sub> Emissions for a Day in 2012

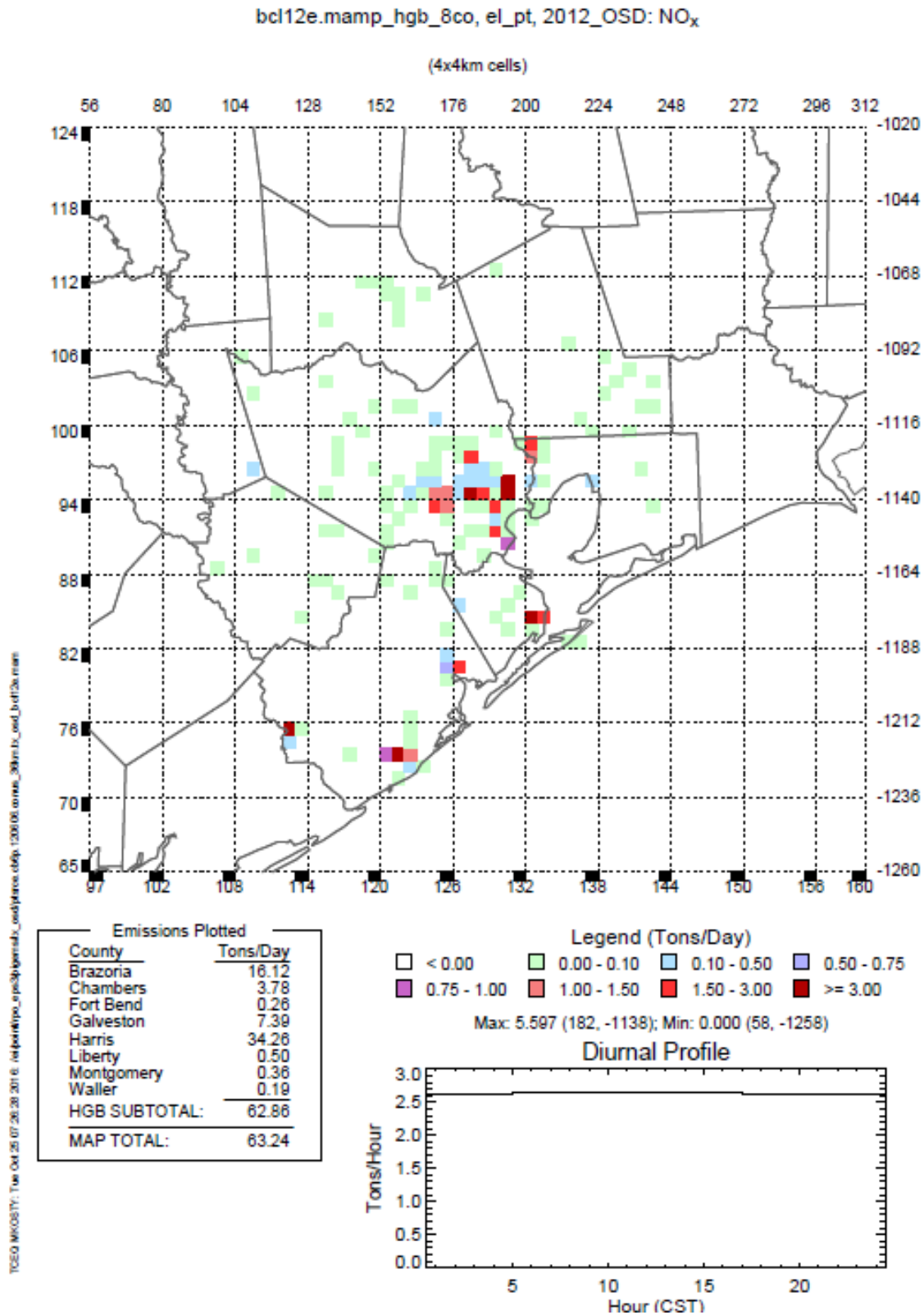


Figure 2-2: Tile Plot of HGB Eight-County OSD Non-EGU Elevated NO<sub>x</sub> Emissions for a Day in 2012

#### 2.1.1.5 Hourly Air Markets Program Data (AMPD)

To enhance emissions accuracy for the base case, data sources with monthly, daily, or hourly temporal resolution are used if available (Thomas et al, 2008). For the EGUs in the state, hourly records from the EPA's AMPD database are substituted for the STARS OSD records. SAS computer programming code removes the source from the OSD file while adding in AMPD hourly records for the source, to avoid any double counting of emissions.

Under the Clean Air Act's Acid Rain Program and the other budget/cap programs for EGUs, each unit reports its emissions of sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>), and carbon dioxide (CO<sub>2</sub>), along with other parameters such as heat input. The EPA quality controls the reported raw hourly data and provides datasets and a query wizard on the AMPD website for downloading the data. Missing or invalid hourly data that arise from CEM equipment problems are generated by the EPA using specific punitive substitution criteria<sup>1</sup>. EGU-reported data (such as input to STARS or the NEI) do not always match that from EPA's AMPD.

Hourly data were downloaded from the EPA's AMPD website for Texas and the rest of the country for the 2012 episode. The AMPD database uniquely identifies point sources by FACILITY ID/ORIS (Office of Research Information Systems) number and UNIT ID/BLRID (boiler identification). FACILITY ID/ORIS identifies the site and UNIT ID/BLRID specifies the source (not the emission stack) within the site. FACILITY ID and UNIT ID appear to be the most current field names used by the EPA's AMPD, whereas, ORIS and BLRID are older terms, which are often still used in regards to the NEI. The TCEQ maintains an internal cross reference that links the FACILITY ID and UNIT ID to an NEI and STARS FIPS/plant/stack/point emissions "path," which provides location, stack, and other parameters needed to model the point source.

For base case and baseline emissions of EGUs, corresponding hourly VOC and CO records were estimated by multiplying the AMPD hourly heat input by the emissions-to-heat input ratios computed from reported STARS VOC and CO annual emissions. Figure 2-3: *Tile Plot of HGB Eight-County EGU NO<sub>x</sub> Emissions for August 7, 2012* is used to graphically QC the modeled emissions. Reported on the tile plots are the emissions totals by county in the lower left hand corner and the corresponding total diurnal profile of the sources in the lower right corner. A colored/shaded tile represents the total quantity of EGU NO<sub>x</sub> tons for a modeled day's 4 km grid cell within the eight-county HGB area. Elevated point sources are not gridded when modeled.

Figure 2-4: *Tile Plot of Texas EGU NO<sub>x</sub> Emissions for August 7, 2012* is a map of EGU NO<sub>x</sub> emissions for Texas (including HGB) on the 12 km grid for a representative day in August 2012. The diurnal profile of Texas EGU NO<sub>x</sub> emissions in Figure 2-4 varies less than the profile of HGB EGU NO<sub>x</sub> emissions in Figure 2-3, indicative of baseload EGUs that run almost continuously.

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<sup>1</sup> EPA's Plain English Guide to the Part 75 Rule, June 2009, p. 80, [http://www.epa.gov/airmarkets/documents/monitoring/plain\\_english\\_guide\\_part75\\_rule.pdf](http://www.epa.gov/airmarkets/documents/monitoring/plain_english_guide_part75_rule.pdf)

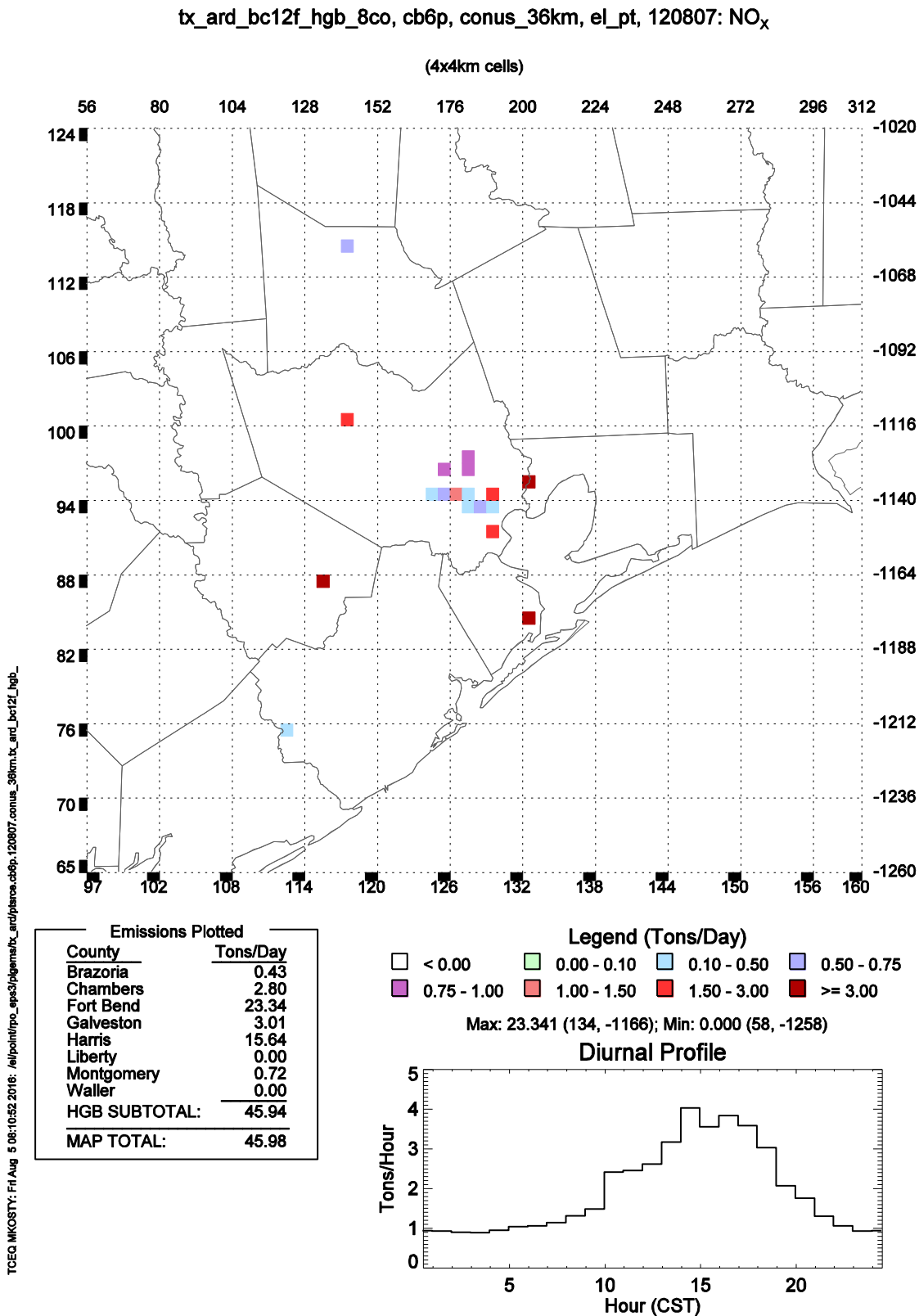


Figure 2-3: Tile Plot of HGB Eight-County EGU NO<sub>x</sub> Emissions for August 7, 2012

tx\_ard\_bc12f, cb6p, conus\_36km, el\_pt, 120807: NO<sub>x</sub>

(12x12km cells)

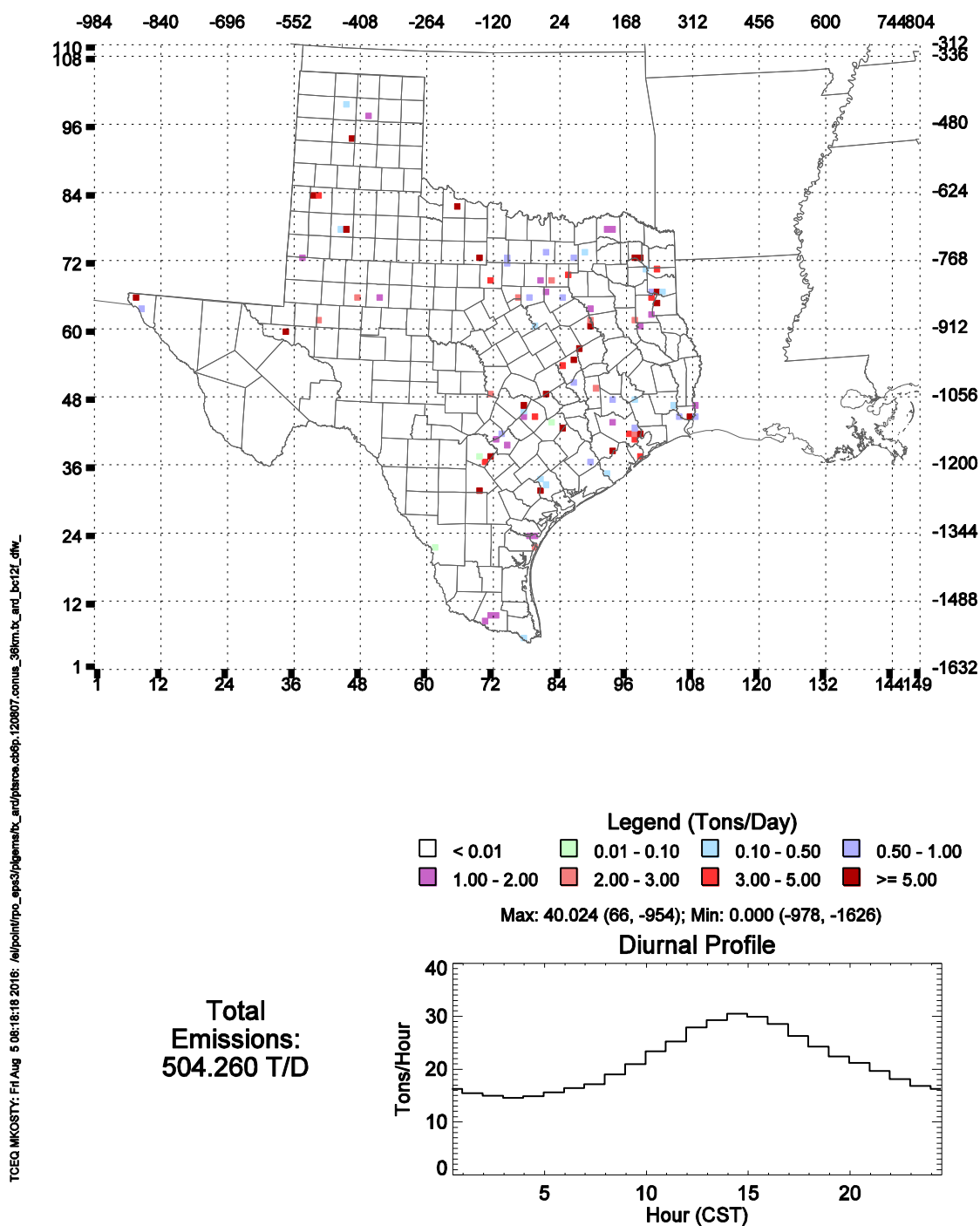


Figure 2-4: Tile Plot of Texas EGU NO<sub>x</sub> Emissions for August 7, 2012

### 2.1.2 Regional (Outside of Texas) Point Sources

This section discusses the point source modeling emissions development for the following areas outside of Texas within the modeled CAMx domain:

- Continental U.S. (CONUS) outside of Texas;
- Offshore (Gulf of Mexico);
- Mexico; and
- Canada.

#### 2.1.2.1 Regional NEI for Non-EGUs

The 2012 EI for states outside of Texas was derived from the EPA's 2011 Modeling Platform. The 2011 Modeling Platform was used because it is the closest in year inventory to the base case, and it was not forecast to 2012. Records with rail and airport Source Classification Codes (SCCs) were removed to avoid duplicating emissions with area source categories. An AFS-formatted file was generated for EPS3 processing. The associated temporal allocation file for SMOKE was converted to create the daily-varying temporal distribution of emissions for each day of the episode. Previous AD SIP revisions used a June day to represent a typical ozone season day.

#### 2.1.2.2 Regional Hourly AMPD Substitution for EGUs

Hourly emissions for EGUs were obtained for 2012 from the EPA's AMPD. The TCEQ replaced the original emission records with hourly records for all of the EGUs in all states outside of Texas by matching the AMPD identifiers, FACILITY ID and UNIT ID. The TCEQ maintains a (ORIS and Unit ID keyed) cross reference that links the 2011-based NEI to the AMPD data.

Location and stack parameters obtained from the NEI are appended to the EGUs to generate an AFS file. All EGUs in the adjacent states of Louisiana, Arkansas, and Oklahoma are the most accurately cross-referenced to assure geographical accuracy. The further away the EGU from Texas, the more tolerance was allowed for geographical location. As with Texas AMPD sources, corresponding hourly VOC and CO records for EGUs matched with the cross reference were generated by multiplying the hourly AMPD heat input by the annual VOC-to-heat input ratio and the annual CO-to-heat input ratio.

AMPD NO<sub>x</sub> emissions for the EGUs of the adjacent states for August 7, 2012 are shown in Figure 2-5: *Tile Plot of EGU NO<sub>x</sub> Emissions for the Adjacent States for August 7, 2012*. The emissions summary in Figure 2-5 is for the 12 km domain, without Texas. AMPD NO<sub>x</sub> emissions for the EGUs of the 36 km CONUS outside of Texas for the same modeled episode day are shown in Figure 2-6: *Tile Plot of EGU NO<sub>x</sub> Emissions for the U.S. (outside of Texas) for August 7, 2012*.



# Non-TX CAMD EGUs, reg\_ard\_bc12d\_aug, 120807: NO<sub>x</sub>

(12x12km cells)

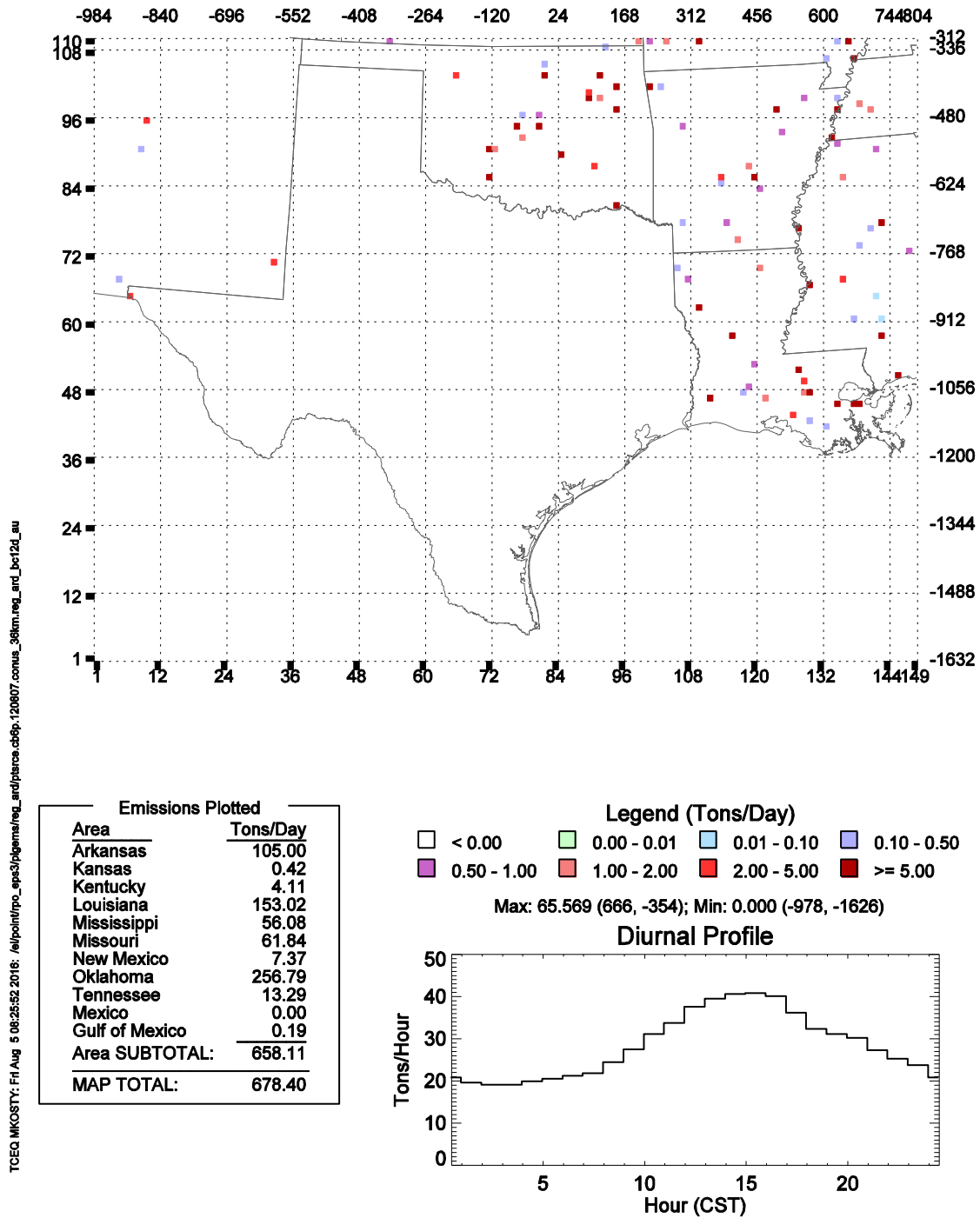


Figure 2-5: Tile Plot of EGU NO<sub>x</sub> Emissions for the Adjacent States for August 7, 2012

# Non-TX CAMD EGUs, reg\_ard\_bc12d\_aug, 120807: NO<sub>x</sub>

(36x36km cells)

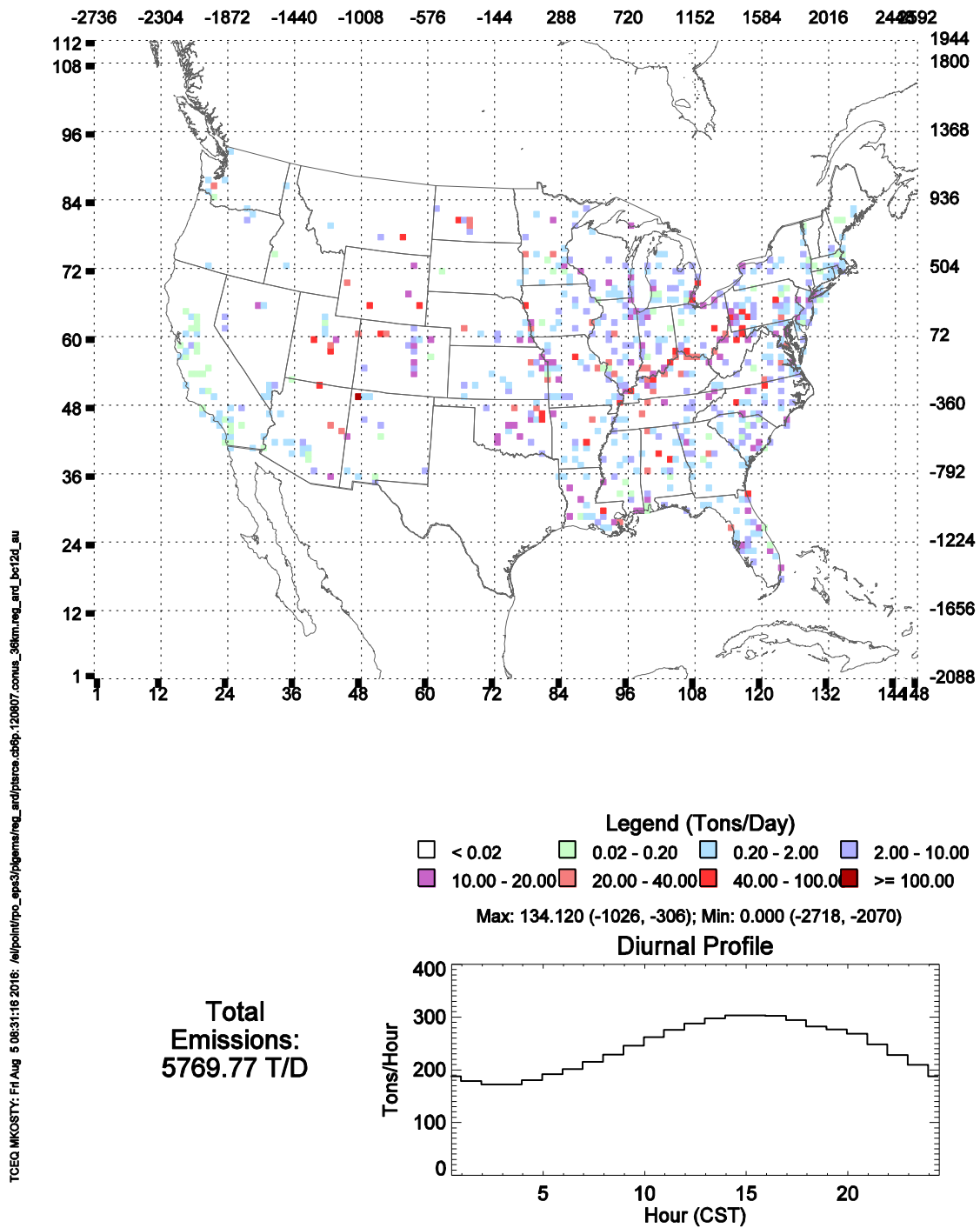


Figure 2-6: Tile Plot of EGU NO<sub>x</sub> Emissions for the U.S. (outside of Texas) for August 7, 2012

### 2.1.2.3 Offshore Point Sources

The TCEQ obtained the 2011 Gulf-Wide Emission Inventory (GWEI), developed by Eastern Research Group (ERG) under contract to the Bureau of Ocean Energy Management (BOEM). The GWEI is typically updated every three years. However, the 2014 GWEI will not be finalized in December 2016, too late for inclusion in this AD SIP revision. The BOEM has indicated to the TCEQ that offshore production fell significantly from 2011 to 2014, and BOEM will use the 2011 GWEI as a typical year in its NAAQS Air Quality Modeling in the Gulf of Mexico Study.

The use of 2011 data is an update to the 2005 data modeled and documented in previous AD SIP revisions. The report and data are divided into two parts, oil and gas exploration and production platform (point) sources, and non-platform (area) sources. The TCEQ did not forecast the 2011 GWEI to 2012. Emissions are provided on a monthly basis for each of the twelve months. Diurnal curves to temporalize the emissions to hourly are not available for the 2011 GWEI, so curves developed for 2008 GWEI were used, as advised in ERG's 2011 documentation. Table 2-2: *GWEI Historical Platform Emissions Summary* summarizes the annual emissions from offshore point sources and shows changes between 2005, 2008 and 2011. The 2011 offshore emissions are illustrated in Figure 2-7: *Tile Plot of Offshore Platform NO<sub>x</sub> Emissions for a Representative Day in August 2011*.

**Table 2-2: GWEI Historical Platform Emissions Summary**

Year	CO (tpy)	NO <sub>x</sub> (tpy)	VOC (tpy)
2005	89,813	82,581	51,241
2008	82,146	74,286	60,824
2011	70,339	84,128	54,724

gwei2011a, all\_pt, Aug 2011 Avg Day: NO<sub>x</sub>

(12x12km cells)

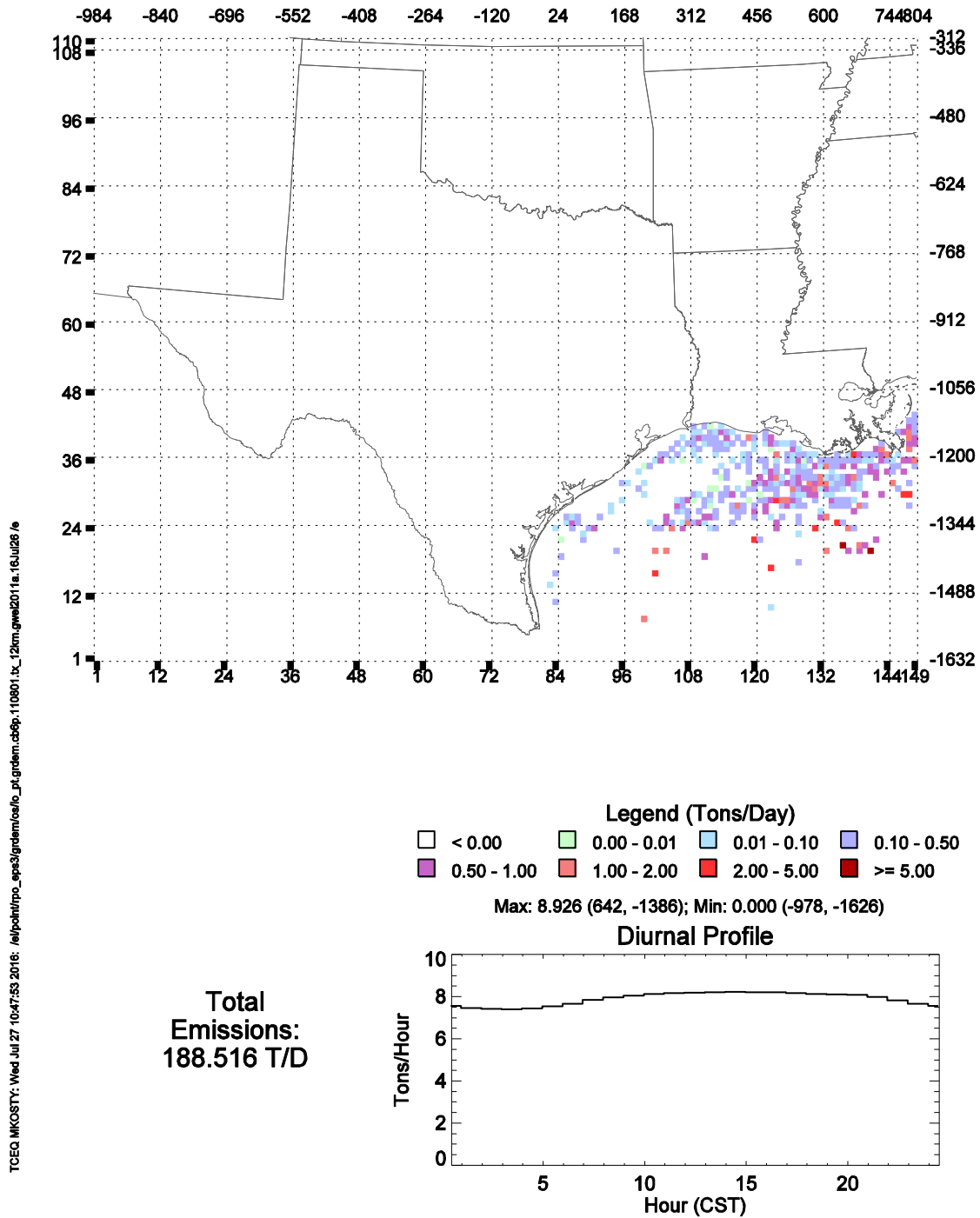


Figure 2-7: Tile Plot of Offshore Platform NO<sub>x</sub> Emissions for a Representative Day in August 2011

#### 2.1.2.4 Mexican Point Sources

The TCEQ used 2008-based Mexico NEI data from the EPA's 2011 Modeling Platform, which was the current data used by the EPA at the time the TCEQ compiled its modeled emissions. The TCEQ downloaded the FF10 format version of the files from EPA's platform ftp location (<ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/>) and converted them into AFS format for EPS3 processing. The EPA Modeling Platform includes annual emissions for 2008 and projections to 2018 and 2025. The TCEQ developed average day 2012 emissions by interpolating between the 2008 and 2018 annual emissions and then dividing by 365 days per year. No temporal allocation or speciation data were available, so emissions were distributed evenly across the episode. Figure 2-8: *Tile Plot of Mexico NO<sub>x</sub> Emissions for an Interpolated 2012 Day* is presented below.

# mex\_fy2012b\_MexID, 120612: NO<sub>x</sub>

(12x12km cells)

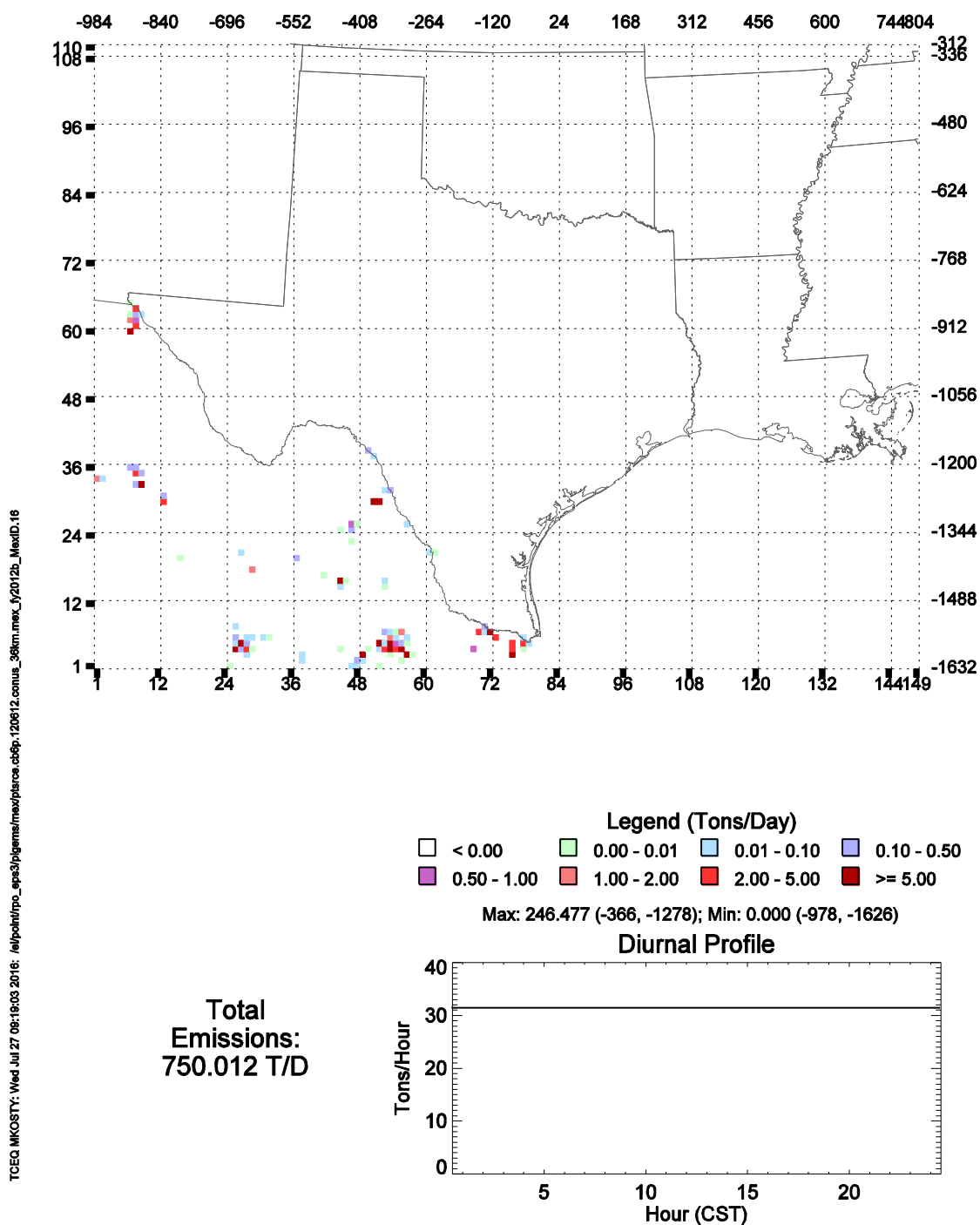


Figure 2-8: Tile Plot of Mexico NO<sub>x</sub> Emissions for an Interpolated 2012 Day

#### 2.1.2.5 Canadian Point Sources

The TCEQ used the 2010 Canadian EI from EPA's 2011 Modeling Platform, which is an upgrade from the 2006 Canadian National Pollutant Release Inventory used in previous AD SIP revisions. The TCEQ downloaded the FF10 format version of the files from EPA's platform ftp location (<ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/>) and converted them into AFS format for EPS3 processing. SCC codes representing non-road sources were removed from the point source files and assigned to the non-road source category. No temporal allocation data were used, so emissions were distributed evenly across the episode. The NO<sub>x</sub> emissions total for Canada decreased from 1,300 tpd in 2006 to 1,057 tpd in 2010. Part of this decrease is due to removing the non-road sources from the point source category. The NO<sub>x</sub> emissions for this dataset are illustrated in Figure 2-9: *Tile Plot of Canadian 2010 NO<sub>x</sub> Emissions for a Day in 2012*.

canada2010, cb6p, conus\_36km, 100803: NO<sub>x</sub>

(36x36km cells)

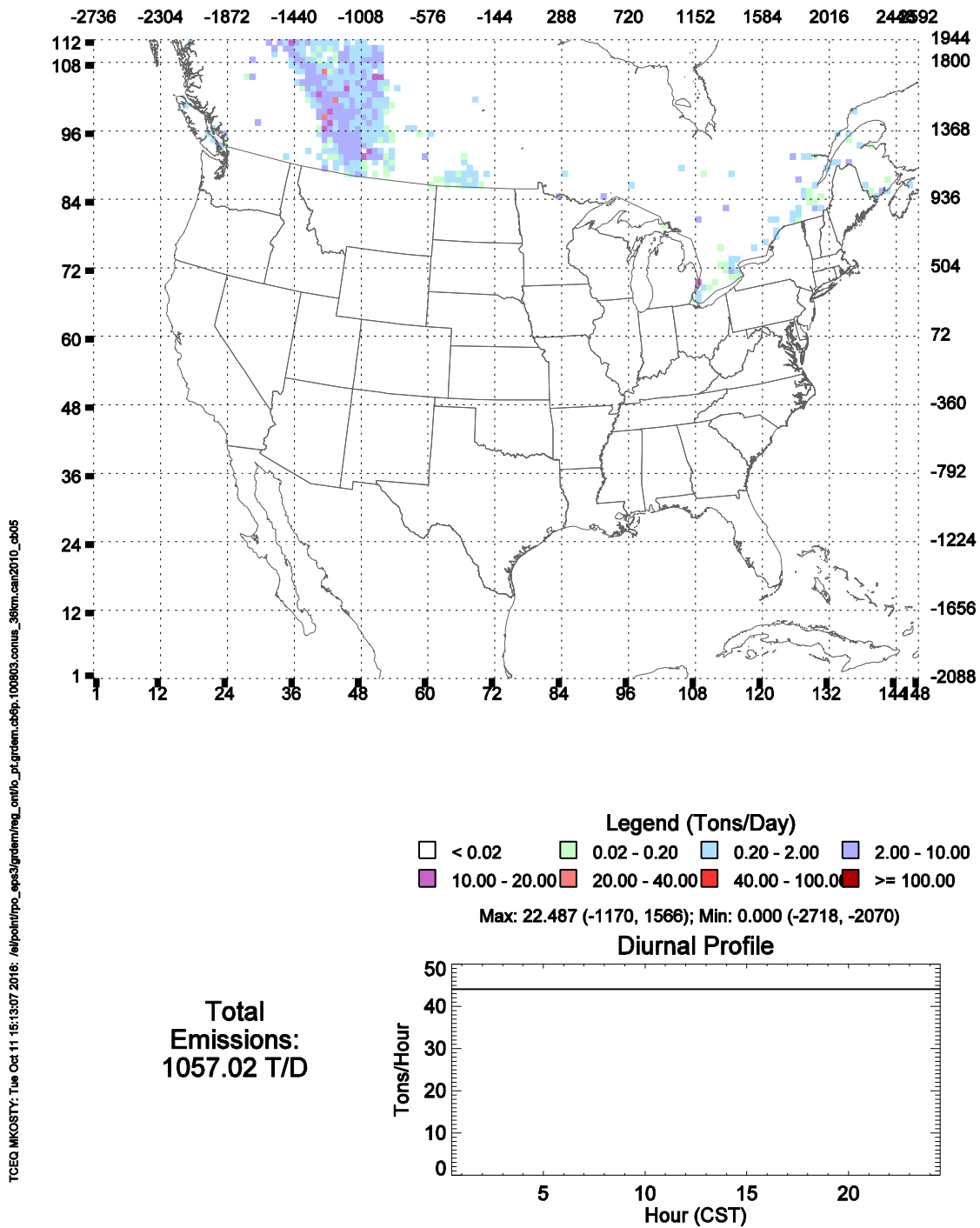


Figure 2-9: Tile Plot of Canadian 2010 NO<sub>x</sub> Emissions for a Day in 2012



### 2.1.3 Plume-in-Grid (PiG) Source Selection

CAMx provides the option to model selected point sources with a PiG algorithm. NO<sub>x</sub> reaction chemistry is enhanced by treating these selected point source plumes as Lagrangian puffs. The GREASD PiG option in CAMx was used, which is most applicable to large NO<sub>x</sub> plumes, for all point sources that met the criteria in Table 2-3: *Summary of PiG Thresholds*.

**Table 2-3: Summary of PiG Thresholds**

Modeled Area	NO <sub>x</sub> Threshold (tpd)
Texas	5.0
Adjacent States (LA, AR, OK) & adjacent Mexican States	7.5
Next ring of USA and Mexican States (MS, etc.)	10.0
Next distant ring of States (AL, etc.)	15.0
Other States, Canada & Offshore	25.0

The NO<sub>x</sub> threshold of 5.0 tpd in Texas denotes that any individual stack or co-located group of stacks with 5.0 or more tpd of NO<sub>x</sub> emissions on an episode day were tracked as a PiG source. The colocation occurs when multiple stacks are close enough together for their plumes to merge (within 200 meters of each other) and the aggregate NO<sub>x</sub> emission rate for the cluster exceeded the threshold value in Table 2-3. A new source was created with the combined NO<sub>x</sub> emission rate of the cluster, and this source was flagged for PiG treatment. The stack parameters of the new source became an average of the stack parameters of all of the sources in the cluster. The TCEQ modeled both individual PiGs and combined PiGs within each of the modeled areas of Table 2-3. The EPS3 module, PiGEMS, provides a summary of the PiG treatment. There were 209 PiG sources tracked for the entire domain, 177 of which were co-located and combined as new stacks.

### 2.1.4 Summary of 2012 Base Case Point Sources

The base case point source emission files processed with EPS3 for CAMx are presented in Table 2-4: *Base Case AFS Files Used for the HGB May to September 2012 Episode*. The regional AFS file for the GWEI contains monthly emissions for the year, the regional AFS file for Canada contains daily emissions that are representative for the entire year, and the regional non-EGU NEI AFS file contains annual emissions. EGU files may be referred to as “ARD” or “AMP”, and non-EGU files may contain “OSD” in the file name text. The [base case point source files](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/point/basecase) are available at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/point/basecase](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/point/basecase). Under the “AFS” subdirectory of this FTP structure is the AFS file format document, “AFS-EPS3-v3.docx”, which provides additional details for the expanded fields that the TCEQ provides in its AFS files.

**Table 2-4: Base Case AFS Files Used for the HGB May to September 2012 Episode**

Area	AFS Point Source Emissions File	Record Type
Texas	afs.osd_for_2012_amp_based_on_2012v7a.v6	Daily
Texas	afs.amp_01Jan_to_31Dec12_episode_all_pols_RPOLcp.v6	Hourly
Regional	afs.2012_USA_noTX_noEGU_v3.RPOLcp	Annual

Area	AFS Point Source Emissions File	Record Type
Regional	afs.amp_USA_Mar2Sep_episode_all_pols_RPOLcp	Hourly
Regional	afs.gwei.2011.lcpRPO	Monthly
Regional	afs.Mexico_2012_Interpolate_from_EPA2011PlatformV2_MexID.RPOLcp	Daily
Regional	afs.2010CanadaCB05species.RPOLcp and afs.2010Canada_noCB05species.RPOLcp	Annual

The TCEQ chose the first Tuesday of August 2012 as a representative day for reporting base case emissions totals. August 7, 2012 was a high ozone day with elevated NO<sub>x</sub> concentrations. Table 2-5: *2012 Base Case Emissions Summary for August 7, 2012* summarizes emissions for that day.

**Table 2-5: 2012 Base Case Emissions Summary for August 7, 2012**

Emissions Source	HGB NO <sub>x</sub> (tpd)	HGB VOC (tpd)	Rest of Texas NO <sub>x</sub> (tpd)	Rest of Texas VOC (tpd)	Regional NO <sub>x</sub> (tpd)	Regional VOC (tpd)
Non-EGUs (OSD)	69.8	130.7	417.6	354.9	3751.4	2277.9
EGUs (AMPD)	46.0	4.9	458.3	23.4	5769.8	93.8

## 2.2 2012 BASELINE POINT SOURCE MODELING EMISSIONS DEVELOPMENT

The 2012 point source emissions used in the base case are specific to individual days and hours for the EGU portion of the EI. For the baseline case, monthly files were created that represent a typical ozone season day in 2012. The following subsections discuss how the baseline emissions differ from the base case.

### 2.2.1 Texas Point Sources

#### 2.2.1.1 Texas Non-EGU Baseline

The non-EGU emissions for the typical 2012 baseline day are the same as the 2012 base case non-EGU emissions, as these are the average OSD emissions extracted from STARS.

Table 2-6: *Texas 2012 Baseline Non-EGU Emissions Summary* shows the modeled ozone precursor 2012 baseline emissions totals for point sources in the HGB eight-county nonattainment area (NAA), the DFW 10-county NAA, and the rest of Texas. The “#points” entries in Table 2-6 are the total number of NO<sub>x</sub> or VOC point sources in that area. Emissions were summed within the area to give the area emissions total.

**Table 2-6: Texas 2012 Baseline Non-EGU Emissions Summary**

Area	NO <sub>x</sub> # points	NO <sub>x</sub> tpd	VOC # points	VOC tpd
HGB	5422	69.8	26705	130.7
DFW	2042	33.1	6331	47.7
Rest of TX	9437	384.5	27817	307.2

### 2.2.1.2 Texas EGU Baseline

To develop an EGU baseline, the TCEQ averaged the AMPD NO<sub>x</sub> for each hour of the day for each unit for each of the five months of the 2012 ozone season (May through September). These data records represent the typical day for each month while maintaining the average diurnal profile of the individual units. Corresponding hourly average CO and VOC emissions were calculated from STARS stack-specific emissions by multiplying the CO-to-heat input and VOC-to-heat input ratios by the hourly heat input rates for each EGU.. The summary of EGU emissions can be found in Table 2-10: *2012 August Average Baseline Point Source Emissions Summary*.

## **2.2.2 Regional (Outside of Texas) Point Sources**

### 2.2.2.1 Regional Non-EGU Baseline

For the states outside of Texas, the TCEQ used the EPA's 2011 Modeling Platform non-EGU file generated for the base case. Table 2-7: *Regional 2012 Baseline Non-EGU Emissions Summary* summarizes the 2012 baseline non-EGU emissions extracted from the NEI for the adjacent states and other states outside Texas.

**Table 2-7: Regional 2012 Baseline Non-EGU Emissions Summary**

State	NO <sub>x</sub> tpd	VOC tpd
Arkansas	81.88	59.72
Louisiana	311.15	143.70
Oklahoma	219.84	123.64
Other States outside Texas	3138.48	1950.89

A typical day for each of the months modeled, derived from temporal profiles from the EPA's 2011 Modeling Platform, was used for the baseline.

### 2.2.2.2 Regional EGU Baseline

To develop the 2012 EGU baseline for the other states, the TCEQ averaged the AMPD NO<sub>x</sub> for each hour of the day, for each unit, and for each of the five months (May through September) to create a typical day for each modeled month. VOC and CO emissions for each hour of the month were calculated as the product of the hourly AMPD NO<sub>x</sub> emissions and the 2011 NEI VOC-to-heat input and CO-to-heat input ratios. The summary of EGU emissions can be found in Table 2-10.

### 2.2.2.3 Offshore, Mexico, and Canada

The 2008 Mexican NEI (interpolated to 2012), and the 2006 Canadian baseline point source files are the same as the base case files, and were modeled as an average day. The offshore point source emissions from the 2011 GWEI for the baseline are the same as the base case and are modeled as an average day per month.

## **2.2.3 Summary of 2012 Baseline Point Sources**

A summary of the point source industries by Standard Industrial Classification (SIC) within the eight-county HGB nonattainment area is provided in Table 2-8: *2012 HGB Point Source Baseline Emissions by Industry*. Ten industry types emitted more than 1.0 NO<sub>x</sub> tpd in 2012, with 79 other SICs reporting smaller emissions. The Industrial

Organic Chemicals, Electric Services (includes the EGUs), and Petroleum Refining SICs reported the vast majority of NO<sub>x</sub> and VOC emissions.

**Table 2-8: 2012 HGB Point Source Baseline Emissions by Industry**

SIC Code	SIC Description	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
2869	Industrial Organic Chemicals, Not Elsewhere Classified	33.88	39.46	26.10
4911	Electric Services (includes the EGUs)	32.81	3.54	39.19
2911	Petroleum Refining	22.16	31.14	16.87
2813	Industrial Gases	2.50	0.69	3.98
4931	Electric and Other Services Combined	2.39	0.41	1.91
1321	Natural Gas Liquids	1.78	3.38	2.09
1311	Crude Petroleum and Natural Gas	1.30	9.00	2.18
2819	Industrial Inorganic Chemicals	1.08	0.86	0.68
2821	Plastic Materials and Resins	1.05	7.31	2.65
2865	Cyclic Organic Crudes and Intermediates, and Organic Dyes and Pigments	1.03	0.48	0.31
	Remaining 79 SICs Less Than 1.0 NO <sub>x</sub> tpd	6.27	38.31	9.49
	HGB Point Source Total (89 SICs)	106.25	134.59	105.43

The point source emission files that were processed with EPS3 for CAMx for the baseline are presented in Table 2-9: *AFS Files for the 2012 Baseline*. The regional AFS file for the GWEI contains monthly emissions, and the regional AFS file for Canadian emissions contains annual emissions. EGU files may be referred to as “ARD” or “AMP”, and non-EGU files may contain “OSD” in the file name text. The [2012 baseline point source files](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/point/) are available at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/point/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/point/).

**Table 2-9: AFS Files for the 2012 Baseline**

Area	AFS Point Source Emissions File	Emissions Record Type
Texas	afs.amp_MAY_2012_average_all_pols_RPOLcp afs.amp_JUN_2012_average_all_pols_RPOLcp afs.amp_JUL_2012_average_all_pols_RPOLcp afs.amp_AUG_2012_average_all_pols_RPOLcp afs.amp_SEP_2012_average_all_pols_RPOLcp	Hourly
Texas	afs.osd_for_2012_amp_based_on_2012v7a.v6	Daily
Regional	afs.ard_USA_MAY_2012_average_all_pols_RPOLcp afs.ard_USA_JUN_2012_average_all_pols_RPOLcp afs.ard_USA_JUL_2012_average_all_pols_RPOLcp afs.ard_USA_AUG_2012_average_all_pols_RPOLcp afs.ard_USA_SEP_2012_average_all_pols_RPOLcp	Hourly
Regional	afs.2012_USA_noTX_noEGU_v3.RPOLcp	Annual

Area	AFS Point Source Emissions File	Emissions Record Type
Regional	afs.gwei.2011.lcpRPO	Monthly
Regional	afs.Mexico_2012_Interpolate_from_EPA2011PlatformV2_MexID.RPOLcp	Daily
Regional	afs.2010CanadaCB05species.RPOLcp and afs.2010Canada_noCB05species.RPOLcp	Daily

Table 2-10: 2012 August Average Baseline Point Source Emissions Summary summarizes the baseline emissions for the month of August. These tabulated emissions are AFS totals input to EPS3. CAMx input VOC values may differ slightly.

**Table 2-10: 2012 August Average Baseline Point Source Emissions Summary**

Emission Source	HGB NO <sub>x</sub> (tpd)	HGB VOC (tpd)	Rest of Texas NO <sub>x</sub> (tpd)	Rest of Texas VOC (tpd)	Regional NO <sub>x</sub> (tpd)	Regional VOC (tpd)
Non-EGUs (OSD)	69.8	130.7	417.6	354.9	3751.4	2277.9
EGUs (AMPD)	36.5	3.9	404.7	19.7	5328.5	56.0

## 2.3 2017 FUTURE YEAR POINT SOURCE MODELING EMISSIONS DEVELOPMENT

This section describes the development of the 2017 future year point source EI.

Much goes into the foundation for the future case point source EI prior to control strategies and/or sensitivity analyses, including a point source emissions inventory starting point (the projection base), impact of emissions banking and trading programs, economic growth projections, changes in the Texas EGU fleet, existing and anticipated federal, state, and local regulations, and emissions reduction measures.

The TCEQ uses the most complete and accurate data available at the time for the emissions inventory development. For this AD SIP revision, the 2017 future case EI was developed using the most recent STARS and AMPD data sets available, 2014 and 2015, respectively. These projection base years become the SIP EI years used in the analysis for future potential emission reduction credit generation. The future case EI provides the basis to determine if attainment has been reached and is the starting point for control strategy testing and/or future year sensitivity analyses. In general, projection base year emissions are grown to the attainment year and existing on-the-books controls (those that will be in place after the baseline year and prior to the future year) are applied.

### 2.3.1 Regulations and the Cap-and-Trade Programs

In some instances, growth of future emissions is limited by regulation. Prior to discussing growth and the development of emission files for specific point source categories and areas of the state, a description of the various regulations and trading programs is provided here, since they are referenced in several sections below.

In Texas and other covered states, the EPA's Cross-State Air Pollution Rule (CSAPR) became effective January 1, 2015, and limits the ozone season (May through September) NO<sub>x</sub> emissions from subject EGUs. CSAPR is a federal program administered by the EPA. On September 7, 2016, the EPA finalized the CSAPR Update Rule to address interstate transport obligations related to the 2008 eight-hour ozone NAAQS. The CSAPR Update Rule finalized more stringent ozone season NO<sub>x</sub> emissions state budgets for 22 states (including Texas) that are currently subject to the existing CSAPR ozone season NO<sub>x</sub> program, removed 3 states (North Carolina, South Carolina, and Florida) from the CSAPR ozone season NO<sub>x</sub> program, and added a new state (Kansas) to the CSAPR ozone season NO<sub>x</sub> program. Since the CSAPR Update Rule only addressed the interstate obligations of the 2008 eight-hour ozone NAAQS, the CSAPR annual NO<sub>x</sub> and SO<sub>2</sub> programs remain unaffected. For this HGB AD SIP revision, the future emissions of sources subject, in Texas and other states, to the CSAPR ozone season NO<sub>x</sub> program were determined taking into consideration the CSAPR Update Rule provisions and budgets.

In the eight-county HGB NAA, the Mass Emissions Cap-and-Trade (MECT) program limits annual NO<sub>x</sub> emissions for applicable stationary point source equipment. In Harris County, HRVOC Emissions Cap-and-Trade (HECT) limits annual HRVOC emissions for certain point sources. Besides MECT, HECT, and CSAPR, there are other regulations and agreements that affect certain NO<sub>x</sub> sources in the state, some of which have compliance dates between the projection base years (2015 for Texas EGUs and 2014 for all other Texas point sources) and the attainment year of 2017. For most regulations, the compliance date has already passed and emissions are accurately modeled using the reported projection base year(s) emissions. Additionally, specific for the DFW NAA, the Ellis County cement kilns (near Midlothian) are capped (by site) by a NO<sub>x</sub> emissions limit.

#### 2.3.1.1 CSAPR Background

The EPA's CSAPR program that became effective January 1, 2015 requires states to address interstate transport related to the 1997 eight-hour ozone standard and the 1997 annual and 2006 24-hour particulate matter of 2.5 microns and less (PM<sub>2.5</sub>) standards in 28 eastern states, including Texas. The program limited annual NO<sub>x</sub> and SO<sub>2</sub> emissions for affected EGUs in Texas and 20 other states, as well as NO<sub>x</sub> emissions during ozone season in 25 states, including Texas. The definition of an EGU for the CSAPR program is approximately the same definition as that for a Federal Clean Air Act Title IV Acid Rain unit, i.e., larger than 25 MW and more than one-third of its generation going to the public grid for sale. CSAPR is a cap-and-trade program, with EPA providing ozone season NO<sub>x</sub> and/or annual NO<sub>x</sub> and SO<sub>2</sub> budgets for each applicable state.

CSAPR specified ozone season NO<sub>x</sub> and annual NO<sub>x</sub> and SO<sub>2</sub> emissions caps<sup>2</sup> for most AMPD EGUs in Texas (and other CSAPR states). CSAPR sources are allocated a specific amount of allowances for each compliance period (ozone season or annual), referred to as allocations. The sum of each state's allocations of all CSAPR sources for each compliance period equals the EPA-prescribed state's budget for that compliance period. At the end of each compliance period, each site with CSAPR sources must have sufficient allowances to cover the total emissions from all its CSAPR sources. Subject

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<sup>2</sup> <http://www.epa.gov/airtransport/CSAPR/stateinfo.html#states>

sources can purchase or sell allocated allowances, so their annual emissions in any compliance period are not limited to their allocation for that period. The reconciliation of available allowances and emissions is done by the EPA following the completion of the compliance period. Allowances not needed in a compliance period can be banked and are available for the site to use in future compliance periods. While the state budget is distributed to each subject source, compliance is determined at the site level.

The CSAPR Update Rule finalized more stringent state budgets for the CSAPR ozone season NO<sub>x</sub> program effective May 1, 2017. In addition, to the updated state budgets, the CSAPR Update Rule has a provision for a one-time conversion of banked 2015 and 2016 CSAPR allowances into allowances that can be used for compliance with the more stringent state budgets starting from the 2017 compliance period. This provision is available to all states subject to the new CSAPR ozone season NO<sub>x</sub> program caps except Georgia whose budget was not revised as part of the CSAPR Update Rule. As CSAPR is a new cap-and-trade program, the TCEQ has no history of how EGUs have complied or will comply with this program; therefore, the EPA's allocations provided with the CSAPR Update Rule were utilized to determine 2017 future case EGU emission estimates within Texas. In addition, some sources in CSAPR are in the HGB MECT program. The TCEQ accounts for the cap-and-trade aspects of CSAPR and the overlap of CSAPR and MECT programs by limiting the future emissions of sources subject to both these cap-and-trade programs to the MECT program cap.

#### 2.3.1.2 MECT Background

The MECT program provides NO<sub>x</sub> emission limits for applicable sources as specified in 30 TAC §101.351. The MECT program covers most NO<sub>x</sub>-emitting sources (equipment) in HGB. Sites with these point sources comply with the source category emissions limits specified in 30 TAC Chapter 117 via a cap-and-trade program. The TCEQ allocates a specific amount of allowances to each point source (i.e., piece of equipment) at a site (account, RN) for each compliance year. Similar to the CSAPR program, the MECT program also allows banking and trading of allowances. A key difference between the CSAPR and MECT programs is that in the MECT program, unused allowances can be banked only for one additional compliance year, whereas in CSAPR, unused allowances can be banked indefinitely. To comply with the MECT program, each site in the MECT program should have sufficient allowances to cover the total annual emissions from all its MECT sources. The TCEQ QC's the annual reports, submitted by subject sites, to verify that the site has allowances equivalent to the total NO<sub>x</sub> emissions from the MECT points at the site. Similar to the CSAPR program, annual allowances are distributed to each subject source, but compliance is determined at the site level. More detail about the MECT program can be found in Appendix B of the 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision.

The MECT cap of 39,984.8 tpy or 109.55 tpd from allocations was used in this HGB AD SIP revision. In addition to the allocation portion of the MECT cap, the MECT program allows the use of Discrete ERCs (DERCs) and Mobile DERCs (MDERCs) to be used for MECT compliance. To account for the possible use of DERCs and MDERCs to cover emissions from MECT subject sources, an additional 1,242.1 tpy or 3.4 tpd of emissions was added to the MECT cap. In previous SIP revisions, MECT sites were modeled at their assigned future year allocations, regardless of their trading history. The fact that some MECT sites sell all or a portion of their allowances each year permanently via "stream trades", gave the TCEQ the impetus to model a more spatially-realistic future

case distribution of MECT source emissions, as described below in Section 2.3.1.4 *Modeling the Cap-and-Trade Programs*.

### 2.3.1.3 HECT Background

The HECT program limits HRVOC (ethylene, propylene, butadiene, and all isomers of butene) emissions discharged from applicable point sources in Harris County as specified in 30 TAC §101.391. The HECT program is also a cap-and-trade program similar to the MECT program, with compliance being handled by the TCEQ. The HECT cap applies to HRVOC emissions from commonly included sources such as flares, non-tank stacks, and cooling tower emissions. However, unlike the MECT program, the HECT cap is distributed by site (RN, account) via annual allocations. The HECT cap of 2,590.3 tpy or 7.1 tpd used in this HGB AD SIP revision.

HECT allowances were allocated to applicable sites in proportion to the site's level of activity, determined from each site's selection of a twelve-consecutive-month baseline ranging from 2000 through 2004. HECT sites were given the greater of 5.0 tons of HECT allowances or the allocation from the site, determined from using the equation listed in 30 TAC §101.394(a)(1).

### 2.3.1.4 Modeling the Cap-and-Trade Programs

The TCEQ administers three cap-and-trade programs in Texas: (1) the Emissions Banking and Trading of Allowances program (also known as the SB7 program for EGUs) for SO<sub>2</sub> and NO<sub>x</sub> emissions, (2) the MECT program for NO<sub>x</sub> emissions, and (3) the HECT program for HRVOC emissions. In addition, Texas EGUs are subject to the federal CSAPR program. The SB7 program, which affects EGUs, is not modeled as it is less stringent than CSAPR. The TCEQ models these cap-and-trade programs by determining the total future emissions of sources subject to these cap-and-trade programs by taking into consideration the appropriate program's total future year cap, the trading history of subject sources, and other provisions of the program. If multiple programs cover a set of sources, the program with the smallest geographic area is modeled. The three cap-and-trade programs used to model future year NO<sub>x</sub> and HRVOC emissions are summarized in Table 2-11: *2017 Caps for Cap-and-Trade Programs in Texas*. SO<sub>2</sub> is not a modeled precursor for ozone, so it is not included in the CSAPR discussions of this appendix.

**Table 2-11: 2017 Caps for Cap-and-Trade Programs in Texas**

Program	Pollutant Affected	Geographical Scope of Program	2017 Program Cap for Texas Sources
CSAPR	NO <sub>x</sub>	Texas and 21 other states	52,301 tons for the May-September ozone season
MECT	NO <sub>x</sub>	HGB Nonattainment Area	40,176.2 tpy
HECT	HRVOC	Harris County	2,590.3 tpy

To help transition EGUs from the CSAPR ozone season NO<sub>x</sub> state budgets finalized in 2015 to the more stringent 2017 ozone season NO<sub>x</sub> state budgets finalized under the CSAPR Update Rule, the final rule has a provision that transitions a limited number of banked 2015 and 2016 CSAPR allowances via one-time conversion into 2017 allowances. The conversion will be completed no later than March 1, 2018 and will be



based on the amount of banked 2015 and 2016 allowances available after the completion of the 2016 CSAPR ozone season NO<sub>x</sub> program compliance period using the conversion formula specified in the CSAPR Update Rule. The EPA estimates that the total amount of converted CSAPR allowances could be approximately 99,700, which will be distributed to all states, except Georgia, subject to the CSAPR NO<sub>x</sub> ozone season program. Since the total ozone season NO<sub>x</sub> emissions from Texas EGUs in 2015 was greater by 3,108 tons than the 2017 ozone season NO<sub>x</sub> program cap finalized in the CSAPR Update Rule, the TCEQ augmented the CSAPR ozone season NO<sub>x</sub> program cap specified in Table 2-11 by 3,773 tons. The additional 3,773 tons was determined based on the difference between the 2015 ozone season NO<sub>x</sub> emissions and the updated 2017 ozone season NO<sub>x</sub> program cap and the estimated 99,700 tons of additional 2017 allowances from banked 2015 and 2016 banked allowances. Hence, the 2017 emissions of Texas EGUs were modeled at a model cap of 56,074 tons. Similar to Texas, the other states except Georgia in the updated CSAPR ozone season NO<sub>x</sub> program were also modeled at emissions that were higher than the prescribed CSAPR 2017 ozone season NO<sub>x</sub> state budgets specified in the CSAPR Update Rule. The additional 99,700 tons of converted banked 2015 and 2016 allowances were spread proportionally to each unit based on the 2017 unit allocations specified as part of the CSAPR Update Rule.

The spatial representation of future year emissions of the sources subject to these cap-and-trade programs is made uncertain due to the trading provisions of these programs. The information currently available to estimate future emissions from sources subject to cap-and-trade programs includes the future year program cap, future year allocation for subject sources, and historical compliance trends for previous compliance periods<sup>3</sup>. While the total future emissions from the sources subject to each program is limited to the 2017 program cap listed in Table 2-11, the TCEQ spatially distributed the 2017 cap to sources expected to be operational in the future using historical trend analysis for the MECT and HECT programs as detailed below. The distributed annual 2017 site emissions (tpy) were converted to future year ozone season day emissions (tpd). The distribution of the 2017 program cap described here is intended to spatially represent future year emissions for modeling purposes only and does not take the place of official allocation of allowances associated with these programs.

Since the CSAPR Update Rule revised the CSAPR ozone season NO<sub>x</sub> program cap and there is no historical compliance and/or trading information, the TCEQ used the EPA's tabulated 2017 allocations provided with the Update Rule to project future year emissions. Because this SIP revision addresses ozone, the TCEQ modeled the CSAPR ozone season caps, except for Minnesota, North Carolina, South Carolina, Florida and Nebraska, which are subject to the CSAPR annual NO<sub>x</sub> program and were modeled as such. Since electricity generation is higher during the hottest months, operational profiles based on 2015 measurements were used to allocate higher estimates for ozone season modeling purposes. Assignment of ozone season NO<sub>x</sub> emissions to EGUs operational in 2015 resulted in a total less than the 2017 CSAPR unit level allocations, so the remainder, plus the CSAPR new units set-aside was used to assign future year

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<sup>3</sup> Details regarding future year allocations for MECT, and HECT can be found in 30 TAC §101.353 and §101.394, respectively. Details regarding CSAPR can be found on EPA's website.

NO<sub>x</sub> caps to newly permitted EGUs, with the remainder spread proportionally among all existing EGUs.

For MECT and HECT, the general procedure for the historical trend analysis used to spatially distribute the future year program caps consisted of the following steps<sup>4</sup>.

1. For each site, the difference between the total reported site emissions and the site's annual allocation for each of the past compliance periods for a program was calculated. The difference was termed "site cap gap."
2. A positive site cap gap for a compliance year indicated that the site had leftover allowances that it could potentially sell to other sites in the program (a spatial trade) or bank for future use (a temporal trade). A site with a positive cap gap is a potential "Seller" (spatial or temporal). Similarly, a site with a negative site cap gap indicated that the site purchased allowances (spatially or temporally) for compliance purposes and was termed "Buyer." The terms Seller and Buyer are used to refer to the potential to trade and not actual trades. In each compliance year, a site is a Seller or a Buyer in each program based on the site cap gap for that program.
3. If a site was a Seller (had a positive cap gap) 80%<sup>5</sup> of the time, then the site was termed to have a Seller trend. Similarly, if a site was a Buyer (negative cap gap) 80% of the time, then the site was termed to have a Buyer trend. The 80% cut off for a trend translates into a site being a Buyer or a Seller for a certain number of years depending on the total number of completed compliance years for each program.
4. If a site exhibited a trend and the site's behavior for the projection base year followed the trend, then the annual emissions for the projection base year was assigned as future year emissions to the site. This is because if a site exhibited a trend then it can be reasonably expected to have a similar behavior in the future year. Since the annual emissions from the projection base year were representative of the trend behavior, the projection base year emissions are considered to be representative of expected future year emissions. For this HGB AD SIP revision, due to time constraints, the projection base year used for HECT and MECT is 2014, since this was the latest year for which MECT- and HECT-related compliance information was available from the EBT database.
5. Sites below the 80% threshold were termed as "Neither" Buyer nor Seller. For sites that did not have an identifiable trend or sites that had a trend but the behavior in the projection base year did not follow the identified trend, the future year site emissions were represented using future allocations of allowances.
6. To be conservative and to account for possible yearly variations, the assigned caps were proportionally scaled up such that total annual modeled emissions for all sources subject to these programs equal the program's respective 2017 available caps. The available program caps for MECT and HECT are those listed in Table 2-11.

The historical trend analysis was performed individually for each program. For sources subject to both CSAPR and MECT, the 2017 annual site emissions determined using the

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<sup>4</sup> Data regarding annual emissions and allocations was obtained from the TCEQ's EBT database for MECT and HECT programs.

<sup>5</sup> The 80% cut-off was chosen qualitatively.

historical trend analysis for the MECT program was used to represent future emissions. [Detailed tables](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/point/cap_t_rade) with the results of the historical trend analysis for each program are available at: [http://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/point/cap\\_t\\_rade](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/point/cap_t_rade).

### **2.3.2 Attainment Areas of Texas**

The attainment areas of Texas include all of Texas except HGB and DFW. The subsections below address growth and control implementation separately. Emissions from new facilities/units in attainment and nonattainment areas area also addressed.

#### **2.3.2.1 Attainment Area 2017 Growth Projections**

Different growth projection techniques were applied to the EGUs, which have AMPD hourly data, and the non-EGUs. The techniques used are similar to EPA projection methods for modeling future cases, except that the TCEQ does not use the Integrated Planning Model (IPM) for EGUs.

##### *EGUs*

To develop the EGU 2015 projection base, the TCEQ averaged the AMPD NO<sub>x</sub> for each hour of the day for each unit for each month of the May through September ozone season, similar to the procedure that generated the 2012 baseline EGUs. The most recent dataset was used because it is newer and contains more of the actual emissions growth from newer units. It is a better estimate of future emissions to use actual emissions rather than permitted emissions.

The TCEQ generates hourly emissions records for the non-AMPD pollutants (NH<sub>3</sub>, CO, PM<sub>2.5</sub>, and VOC) for AMPD point sources using 2014 heat input data. From STARS, the TCEQ obtains annual emissions for each pollutant and computes a pollutant-to-heat input ratio from the annual totals. The heat input and emission totals should be from the same year, but a given year's set of ratios can be used for another year if one of the datasets (e.g., STARS) is not available. With a valid set of pollutant-to-heat input ratios, hourly emissions were calculated for each pollutant based on the AMPD hourly heat input.

The complete set of Texas EGUs for future case modeling consists of the 2015 EGUs and the post-2015 new EGUs (e.g., newly-permitted EGUs) discussed in the following section. As with previous AD SIP revisions, the TCEQ assumes that the EGU growth in the state comes in the form of newly-permitted EGUs.

##### *Newly-Permitted EGUs*

It is most accurate to provide known growth/expansions at the physical locations where they are projected to occur, rather than growing existing emissions in place. Growth in EGUs in Texas is accomplished with the addition of newly-permitted EGUs since the projection base year, all within the constraints described in the controls subsection below, in addition to TCEQ New Source Review permitting requirements. This subsection describes the procedures for developing the newly-permitted EGU EI. It includes the new units in attainment and nonattainment areas.

Texas EGU emissions for 2017 were developed by researching and compiling data from various sources, which include the Electric Reliability Council of Texas (ERCOT), TCEQ air permitting projects with combustion turbines, TCEQ New Source Review Permits, and the U.S. Energy Information Administration (EIA).

Information from these sources includes individual units' disposition (i.e., operating status), new units coming online, units to be mothballed, and units to be shut down or retired. The criteria for adding new units are: (1) the units are expected to be operational by the end of 2017, (2) the owners applied for, and were granted, a TCEQ air permit, and (3) the owners obtained an Interconnection Agreement (IA) from ERCOT (for those units planned within the ERCOT grid). All three of these conditions must be met in order for the unit(s) to be included in the future case modeling. The TCEQ assumed that units with planned retirement dates prior to the 2017 ozone season on EIA Form 860<sup>6</sup> (2013) or ERCOT's Capacity, Demand, and Reserves report would be retired. All data sources were reconciled to ensure all units were accounted for, and that their status as of August 2016 was modeled. Because the most recent EGU emissions data for modeling are from 2015 AMPD, new EGUs are based on additions and changes subsequent to 2015.

ERCOT covers approximately 85% of the power grid in the state. For the three years between December 2014 and December 2017, a comparative analysis was performed to verify that all new units planned by ERCOT are accounted for, and there is ample generation proposed from the newly permitted units to meet the projected demand in electricity. For 2017, ERCOT projects approximately 1400 megawatts of new resources providing service to the grid and a reserve margin of approximately 18%. The modeled newly-permitted units exceed this megawatt future demand projection, having a total of approximately 4500 megawatts. The excess is due to including units in this analysis that plan to start in 2017 but not provide service to the ERCOT grid until 2018.

Newly-permitted EGU emissions were calculated based on the permit Maximum Allowable Emission Rates Table (MAERT), which is almost always greater than actual operating emissions. Pollutants acquired from the permits were NO<sub>x</sub>, VOC, and CO. The method of determining the allowable emissions differs based on the type of unit and its primary purpose for being constructed. For example, coal plants may have a 30-day rolling average emission rate, while gas turbines may have a short-term allowable emission rate in pounds per hour (pph) and/or a long term allowable emission rate in tpy. In some cases, a unit may have a combination of the above, in addition to maintenance, startup and shutdown (MSS) emission limits.

When available, the 30-day pph emissions limitation was used. These have most often been available for solid fuel-fired units. This time frame represents a good compromise between the standard short-term allowable, which sometimes includes MSS, and the standard long-term permit allowable.

MSS permitting has become more routine in the last several years. These activities help provide a more realistic operating scenario than the maximum of the short-term or long-term emission rates. This is especially important for those units that have many MSS events during a typical summer, such as the peaking units, which operate only

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<sup>6</sup> <http://www.eia.gov/electricity/data/eia860/>

during the peak demand times. MSS limits vary between permits, depending on specific representation in permit applications. Examples of permitted MSS and how they are modeled are described in the Appendix B, Section 2.3.1.1.1 of 2010 HGB 1997 Eight-Hour Ozone AD SIP Revision.

The emission rates calculated represent worst-case for some units, but for most, they represent a typical summer day during the ozone season, corresponding to some of the highest days of electricity demand. If hourly operational data existed for the unit in the AMPD, then modeled emissions were based on those hourly rates; otherwise, new units were assigned emission rates based on their permit. The complete list of newly-permitted EGUs added as the EGU growth in Texas sorted by area is provided as Table 2-12: *Newly-Permitted EGUs (post 2015) in Texas as of August 2016*.

**Table 2-12: Newly-Permitted EGUs (post 2015) in Texas as of August 2016**

Site Name	County	EPN	Permitted <sup>7</sup> NO <sub>x</sub> tpd)
Montana Power	El Paso	GT3	0.105
Montana Power	El Paso	GT4	0.105
PH Robinson	Galveston	PHR1	0.599
PH Robinson	Galveston	PHR2	0.599
PH Robinson	Galveston	PHR3	0.599
PH Robinson	Galveston	PHR4	0.599
PH Robinson	Galveston	PHR5	0.599
PH Robinson	Galveston	PHR6	0.599
Elk Station	Hale	TURB2	0.7702
Elk Station	Hale	TURB3	0.7702
Red Gate	Hidalgo	ENG01	0.7615
Friendswood Energy	Harris	1	0.3484
Wolf Hollow 2	Hood	E-ST3	1.221
Wolf Hollow 2	Hood	E-ST4	1.221
Pinecrest Energy	Angelina	U1	0.381
Pinecrest Energy	Angelina	U2	0.381
Colorado Bend Energy	Wharton	CTDB3-A	1.0641
Colorado Bend Energy	Wharton	CTDB3-B	1.0641
Halyard Wharton	Wharton	CTG1	0.866
Halyard Wharton	Wharton	CTG2	0.866

The NO<sub>x</sub> emission rates in Table 2-12 reflect the calculated NO<sub>x</sub> emissions from permit applications and MAERTs, representing realistic average day emissions, and the NO<sub>x</sub> emission rates after incorporating the existing rules that may apply to the EGUs. The TCEQ assumed NO<sub>x</sub> controls, offsets, or credit purchases will be used to meet these NO<sub>x</sub> emissions rates. VOC and CO rates are modeled at their permitted levels. There

<sup>7</sup> Modeled NO<sub>x</sub> as represented in the paragraphs above the table.

were sufficient CSAPR and MECT allowances available for all newly-permitted EGUs to be modeled at the permitted rates in Table 2-12. Specifically, the new PH Robinson facilities in Galveston County and the Friendswood Energy facility in Harris are in MECT, and there was enough MECT and CSAPR cap to fully fund their 3.94 tpd total permitted NO<sub>x</sub> rate. Likewise, there was enough CSAPR cap to model the remaining new facilities at their permitted NO<sub>x</sub> rates totaling 9.57 tpd.

The temporal distributions of the newly-permitted EGU emissions are based on those of existing units of similar equipment type or SCCs. For each SCC included in the newly-permitted EGU list, an average temporal distribution was calculated, based on diurnal profiles of existing units with the same SCC within the state. For some units on the new EGU list, a corresponding SCC did not exist for existing units. In these cases, the default flat profile was assigned.

### *Non-EGUs*

As with the base case, when the EGUs are removed from the point source EI for hourly treatment, the remainder are non-EGUs. The projection base year for non-EGUs in Texas is the most current, complete, and quality control checked year of STARS emissions. For this HGB AD SIP revision, this is the year 2014.

The TCEQ estimated the 2017 future case emissions by starting with the 2014 projection base and projecting it to 2017 using growth factors developed by ERG in 2016 under contract to TCEQ. These growth factors are an update to the factors developed in 2010 and used in previous SIP revisions. The ERG growth factors<sup>8</sup> are based on county (FIPS) and Standard Industrial Classification (SIC) codes. To manage the growth factors, the TCEQ developed a table that assigned growth factors for all 2014 STARS emissions paths. The ERG data provided growth factors for most of the STARS paths (uniquely identified by FIPS, plant, stack and point). In situations where there was not a FIPS/SIC match, the emissions path was assigned a growth factor equal to the SIC average for the state. If there was no SIC match, the next default applied was the county (FIPS) average growth, and then the statewide average. All pollutants for a path were assigned the same growth factor.

Projection factors were assigned individually to each non-EGU path that does not have a recent rule (or cap) applied to it. No factor was applied to a path that must comply with a rule, since the rule provides an emission rate limit on that path, allowing no growth for that individual piece of equipment. For this AD SIP revision, there were no rules to consider for the projection to the future year. A summary of the EGU and non-EGU growth in the Texas attainment areas for the August average is provided as Table 2-13: *Summary of Texas Attainment Area August Average Ozone Season Growth Projections to 2017*. In Table 2-13, a Projection Method of 1 indicates ERG growth factors were applied to points that do not have recent existing rule limitations; and a Projection Method of 2 indicates the addition of post-2015 point sources (the newly-permitted EGUs with CSAPR applied to these points).

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<sup>8</sup> Factors and documentation are presented on the TCEQ's webpage at [http://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/point/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/point/)

**Table 2-13: Summary of Texas Attainment Area August Average Ozone Season Growth Projections to 2017**

EI	Projection Base Data	Projection Base # points	Projection Base NO <sub>x</sub> (tpd)	Projection Method	2017 Future Case #points	2017 Projected NO <sub>x</sub> (tpd)	Projection Base to 2017 Growth
Non-EGUs	2014 STARS	10167	355.8	1	10167	389.9	9.6%
EGUs	2015 AMPD	264	368.9	2	276	370.3	0.4%

The Texas 2017 non-EGU NO<sub>x</sub> emissions are greater than the total in 2014 due to the growth factors applied. The 2017 EGU emissions are also higher than the 2015, because most of the EGUs were operating under their caps in 2015, but in 2017 were modeled at their CSAPR cap values. Additionally, newly-permitted EGUs were added. The increase in the number of EGU points from 2015 to 2017 can be explained by the addition of the newly-permitted EGUs.

#### 2.3.2.2 Texas Attainment Areas 2017 Control Implementation

For this AD SIP revision, the existing TCEQ on-the-books controls for the non-EGUs were already accounted for in the 2014/2015 projection base, because the compliance dates were prior to 2013. To develop the future case EGU emissions, the EPA's CSAPR cap-and-trade program was applied.

#### *EGUs*

The TCEQ modeled the CSAPR source emissions as described in Section 2.3.1.4. Also noted in Section 2.3.2.1, the newly-permitted EGUs were modeled at their permitted values using the CSAPR cap that remained after first distributing the cap to the existing EGUs. A summary of the distribution of the CSAPR budget to areas of Texas is provided as Table 2-14: *August Average Distribution of NO<sub>x</sub> CSAPR Allowances in Texas*.

**Table 2-14: August Average Distribution of NO<sub>x</sub> CSAPR Allowances in Texas**

Area	Emissions Basis	Modeled Allowance for 2017 AMPD Units that were Operating in 2015 (tpd)	Modeled Allowance for Newly-Permitted (post 2015) OSD new EGUs (tpd)
HGB	MECT/CSAPR	41.9	3.9
DFW	CSAPR	14.1	0
Attainment	CSAPR	359.7	9.6

The EGU portions of the HGB MECT program also count against the CSAPR budget, as described in sections above. The difference between CSAPR and MECT provides a credit that was distributed to point sources that are in CSAPR but not subject to the MECT program.

#### *Non-EGUs*

An existing program expected to reduce emissions between the 2014 projection base year and 2017 in the attainment areas of the state is the EPA's Petroleum Refinery Initiative. Since the late 1990s, petroleum refineries have been the focus of an EPA enforcement initiative. Since March 2000, the EPA has entered into settlements with 37 petroleum refiners that, collectively, represent 95 percent of U.S. petroleum refining capacity. According to EPA, these settlements, covering 112 refineries in 32 states, including Texas, will result in a reduction of approximately 95,000 tpy of nitrogen oxides (NO<sub>x</sub>) and 260,000 tpy of sulfur dioxide (SO<sub>2</sub>) upon full implementation (EPA, 2016).

The TCEQ has not modeled any reductions for these consent decrees, because (1) it is difficult to determine which reductions were already made as of the end of 2014, and which ones were remaining; (2) most of the agreements do not require NO<sub>x</sub> reductions; and (3) most of them lack enforceable requirements of quantified reductions. The TCEQ has verified that several refineries (some in HGB and Beaumont-Port Arthur) have modified permits to comply with their consent decrees, but permit reductions do not always result in actual reported emission reductions.

### **2.3.3 Nonattainment Areas (NAAs) of Texas**

This section describes the specific growth and control implementation applied to the two ozone NAAs, HGB and DFW. The NAAs were modeled similarly, although HGB is more complex because of the number of TCEQ programs that apply to that NAA. The growth projections to 2017 and any existing controls that will affect the areas between the projection base year(s) and 2017 are described in subsections below. Since emission growth in NAAs is strictly limited by nonattainment New Source Review (NSR) rules and TCEQ control programs, the subsections below address growth and control implementation together.

#### **2.3.3.1 2017 NAA Growth Projections and Control Implementation**

Growth projections were applied to the 2014 and 2015 projection base EIs to obtain the 2017 future case EI. As with the attainment areas of the state, different techniques were applied to the EGUs (2015 projection base year) and the non-EGUs (2014 projection base year).

##### ***NAA EGUs Projections and Control Implementation***

The projection of nonattainment areas into the future begins with a projection base EI for NAA EGUs that is the typical (average)-summer day for each month calculated from AMPD hourly emissions for all days of the May through September 2015 time period. In addition, the CSAPR state budget and program requirements are also considered.

The complete set of 2017 Texas EGUs consists of the existing 2015 AMPD EGUs, the post-2015 newly-permitted EGUs, and any retirement of older/inefficient units. As with previous AD SIP revisions, the TCEQ assumes that the EGU growth in the state comes from newly-permitted EGUs. The Eastern Regional Technical Advisory Committee (ERTAC) EGU projection tool<sup>9</sup> predicts approximately the same amount of new growth for Texas. Similarly, the IPM, which EPA uses for projecting its future case, would add new units when it calculates that new capacity is needed. The TCEQ models the EGU

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<sup>9</sup> A collaborative effort of states, regional planning organizations, and industry.  
<http://www.marama.org/2013-ertac-egu-forecasting-tool-documentation>



growth (newly-permitted units) in Texas at the locations specified in permit applications; neither the ERTAC model nor IPM do this.

#### Existing EGUs in NAAs

All AMPD EGUs in HGB must comply with CSAPR and MECT. CSAPR is an ozone season cap, and the TCEQ's modeling episode corresponds to CSAPR's ozone season compliance period. MECT is an annual cap, and the May through September period must be scaled to reflect cap usage in that time span.

Although MECT is an annual cap, account holders do not use these NO<sub>x</sub> allowances uniformly across the year. MECT EGUs use more allowances during the peak electrical demand period of ozone season. To retain this seasonal variation for MECT EGUs in the future case, the TCEQ computes a set of scaling factors by dividing the annual MECT cap for each account by the sum of its emissions over the 2015 projection base year. The scaling factors are applied to each month of the 2015 projection base year emissions to yield the monthly 2017 future case MECT emissions.

#### Newly-Permitted EGUs in NAAs

Table 2-12 in Section 2.3.3.1 0, lists the newly-permitted EGUs in each area of the state, which represent the EGU growth in Texas. There are seven newly-permitted units in HGB and no new planned units in DFW. There was enough cap left under MECT and CSAPR in HGB to accommodate the 3.94 tpd NO<sub>x</sub> of newly-permitted EGUs (see summary in Section 2.3.3.1 0). Care is taken to preclude double counting point sources that are on the new list but have started reporting emissions to the AMPD.

#### *NAA Non-EGU Projections and Control Implementation*

As with the attainment areas of the state, the projection into the future begins with a projection base EI for Texas NAA non-EGUs (2014 OSD emissions). Emissions from non-EGUs in the NAAs of the state were projected to 2017 using the lesser of the predicted growth with ERG growth factors or the certified credits (ERCs, DERCS, and MDERCs) available in the TCEQ's Emission Credit and Discrete Emission Credit Registries (EBT Credit Registry) as described in the following paragraphs. HGB NO<sub>x</sub> emissions are additionally subject to the MECT program. The ERG growth factors are discussed in Section 2.3.2.1 0.

Major sources of emissions in NAAs cannot grow their emissions of ozone precursors, NO<sub>x</sub> and VOC, without offsetting the emissions increases either by purchasing certified credits from the EBT Credit Registry or by making contemporaneous period reductions as required by the Nonattainment NSR permitting process. The expected future growth for point sources in NAAs is projected with ERG growth factors, in conjunction with how the future emissions may be limited by the amount of certified credits available in the EBT Credit Registry. Historically, ERCs have been preferred for use as offsets in Nonattainment NSR permitting. Therefore, it is assumed that ERCs will be used to cover as much of projected growth as possible, with DERCS being used to cover the remaining projected growth. For the 2017 future case NO<sub>x</sub> emissions, there were sufficient credits to allow the growth predicted with ERG factors. The 2017 future case VOC growth, however, was limited to less than the ERG-predicted growth by the available credits.

The procedure for incorporating the certified credits available in the EBT Credit Registry into the future case begins with extracting the certified credits from the EBT Credit Registry, which can be found on [EBT's Registry](http://www2.tceq.texas.gov/airperm/index.cfm?fuseaction=ebt_dpa.reg) webpage at [http://www2.tceq.texas.gov/airperm/index.cfm?fuseaction=ebt\\_dpa.reg](http://www2.tceq.texas.gov/airperm/index.cfm?fuseaction=ebt_dpa.reg). ERC and DERC totals for each of the NAAs were extracted on September 16, 2016. Table 2-15: *Banked Emissions as of September 16, 2016* summarizes the total tons of emissions associated with the certified ERCs, DERCs, and MDERCs available in TCEQ's EBT Credit Registry as of September 16, 2016. "Modelable Banked" in Table 2-15 refers to the maximum amount of emissions that could be potentially added as growth to the area from certified credits, with the exception of HGB NO<sub>x</sub> DERCs and MDERCs, which could be used for MECT compliance as noted below.

**Table 2-15: Banked Emissions as of September 16, 2016**

NAA	NO <sub>x</sub> ERCs (tpy)	VOC ERCs (tpy)	NO <sub>x</sub> DERCs (tons)	VOC DERCs (tons)	Modelable Banked NO <sub>x</sub> (tpd)	Modelable Banked VOC (tpd)
HGB Registry	275.2	784.5	33260.3	1075.8		
HGB Discounted Registry	211.7	603.5	24629.4	827.5	0.6 ERCs, 67.5 DERCs	1.7 ERCs, 2.3 DERCs
HGB DERCs/MDERCs used for MECT Compliance			1242.1		3.4	
DFW Registry	66.3	103.5	5800.5	8.5		
DFW Discounted Registry	57.7	90.0	5043.9	7.4	0.2 ERCs, 18.3 DERCs	0.2 ERCs, 0.1 DERCs

The available ERC and DERC credits could vary significantly over time. However, given the method by which the TCEQ models growth/projections, small changes in the amount of certified credits available are not expected to affect future case emission projections.

In the HGB NAA, NO<sub>x</sub> DERCs/MDERCs can, with certain restrictions, be used for MECT program compliance. Since NO<sub>x</sub> DERCs/MDERCs used for MECT compliance will not be available for offsetting, the appropriate amount of NO<sub>x</sub> DERCs/MDERCs were deducted from the total NO<sub>x</sub> DERCs/MDERCs that could represent growth in HGB. The amount deducted took into consideration the 10,000 ton annual limit on the use of DERCs for MECT compliance in 30 TAC §101.356, and all the MDERCs in the registry. The resulting HGB NO<sub>x</sub> DERCs/MDERCs that could be used for MECT compliance (3.4 tpd) were added to the MECT cap.

The Discounted Registry totals in Table 2-15 incorporate the offset ratios used for the Nonattainment NSR permitting program for each of the NAAs as of September 16, 2016. The HGB area has an offset ratio of 1.3:1. For relevant sources, 13.0 tpy of ERCs would need to be purchased for a 10 tpy proposed increase. Only 10 tons of emissions will be potentially returned to the modeled airshed in the future.

The resulting modelable banked emissions for 2017 and the predicted growth values for 2017 are depicted in Table 2-16: *Comparison of the 2017 Modelable Bank and Predicted Growth*. For the 2017 future case NO<sub>x</sub> emissions, there were certified credits to allow the predicted growth. The 2017 future case VOC emissions were limited by the modelable bank.

**Table 2-16: Comparison of the 2017 Modelable Bank and Predicted Growth**

Area	Pollutant	2017 Modelable Bank (tpd)	2017 Predicted Growth (tpd)	2017 Limiting Attribute
HGB	NO <sub>x</sub>	0.6 ERCs 67.5 DERCs	1.98	Growth
HGB	VOC	1.7 ERCs 2.3 DERCs	9.33	Bank
DFW	NO <sub>x</sub>	0.2 ERCs 18.3 DERCs	0.37	Growth
DFW	VOC	0.2 ERCs 0.03 DERCs	-0.003	Growth

Table 2-17: *Texas Non-EGU “No-Rules” Growth Summary* shows the growth projected by ERG factors in each of the NAAs, plus the remainder of the state. The growth was only applied to the sources that were not already limited by recent existing TCEQ rules or constrained by emissions caps. The HGB and DFW modelable banked emissions and growth from the ERG factors were compared on a path-by-path basis, automated with SAS programming. Future case emissions were limited to the smaller amount. A path’s share of the bank, based on its fractional emissions of the total, was added to that path’s emissions to account for growth. The sum of these for each area is tabulated in Table 2-17. Note that the potential projected DFW VOC growth was very slightly positive.

**Table 2-17: Texas Non-EGU “No-Rules” Growth Summary**

Area	Projection Index	2014 STARS NO <sub>x</sub> (tpd)	2017 Projected NO <sub>x</sub> (tpd)	Potential NO <sub>x</sub> Growth (tpd)	2014 STARS VOC (tpd)	2017 Projected VOC (tpd)	Potential VOC Growth (tpd)
HGB	ERG factors	18.93	20.91	1.98	115.90	119.80	3.90
DFW	ERG factors	20.45	20.82	0.37	45.25	45.25	-0.00
Attainment	ERG factors	355.77	389.92	34.15	289.44	318.60	29.16

#### HGB MECT Non-EGU NO<sub>x</sub> Control Implementation

The HGB MECT program also limits the amount of NO<sub>x</sub> from all applicable non-EGU sources with a cap. The application of this program and its limits are discussed in Sections 2.3.1.2 and 2.3.1.4 above.

#### HGB HECT Non-EGU HRVOC Control Implementation

The other cap-and-trade program within HGB that applies to non-EGUs is the HECT program, which only applies in Harris County. The application of this program and its limits are discussed in Sections 2.3.1.3 and 2.3.1.4 above. The HRVOC modeling procedure adopted by the TCEQ does not affect the mass flow rates of non-HRVOC compounds in HECT-qualifying point sources.

#### 2017 Texas EI Summary

The future case point source EI is composed of three datasets: (1) hourly EGUs averaged for each month based on 2015, projected to the CSAPR or MECT caps, (2) the addition of newly-permitted EGUs, and (3) 2014 non-EGUs projected to MECT caps where applicable. Table 2-18: *Detailed August Average 2017 NO<sub>x</sub> Emissions Summary for Texas* for Texas provides a 2017 modeled NO<sub>x</sub> emissions summary.

**Table 2-18: Detailed August Average 2017 NO<sub>x</sub> Emissions Summary for Texas**

Region	Projection	Affected Sources	2014 STARS NO <sub>x</sub> (tpd)	2015 AMPD NO <sub>x</sub> (tpd)	2017 Modeled NO <sub>x</sub> (tpd)
HGB	MECT cap	Non-EGUs	50.11		77.39
HGB	MECT cap	Growth under the cap <sup>10</sup>			1.64
HGB	MECT cap	EGUs		36.84	41.95
HGB	MECT cap	New EGU Growth			3.94
HGB	Growth/bank	non-EGUs	18.93		20.91
DFW	CSAPR cap	EGUs		11.03	22.61
DFW	Cap	DFW Cement Kilns	8.14		17.6
DFW	Growth	non-EGUs	20.45		20.82
Rest of TX	CSAPR cap	EGUs		360.60	359.74
Rest of TX	CSAPR cap	New EGU Growth			9.58
Rest of TX	Growth	Non-EGUs	355.77		389.92

### **2.3.4 2017 Regional (Outside of Texas) Point Sources**

Regional emissions include states outside of Texas within the modeling domain, offshore Gulf of Mexico, and the parts of Mexico and Canada within the modeling domain.

#### 2.3.4.1 EGUs

To develop the 2017 future case EGUs for states outside of Texas, the TCEQ used the updated CSAPR state budgets for states subject to the CSAPR ozone season NO<sub>x</sub> and annual NO<sub>x</sub> program where applicable, and 2015 AMPD data for the rest. The TCEQ used the updated unit-level allocations specified by the EPA as part of the CSAPR Update Rule for each state to derive an average ozone season day. As detailed in Section 2.3.1.4, the TCEQ augmented the updated CSAPR ozone season NO<sub>x</sub> program

<sup>10</sup> These are MECT allowances that were assigned to accounts that could not be matched in the 2014 STARS EI which were distributed as growth to existing MECT accounts.

state budgets for each subject state, except Georgia, by a limited amount of banked 2015 and 2016 allowances to reflect the provisions specified in the CSAPR Update Rule. The total 2017 regional CSAPR NO<sub>x</sub> ozone season program cap (for all 21 states, excluding Texas) modeled is 384,131 tons. States such as Minnesota, North Carolina, South Carolina, Florida and Nebraska subject to the CSAPR annual NO<sub>x</sub> program were modeled based on their annual NO<sub>x</sub> caps.

The TCEQ did not estimate EGU growth (e.g., with proposed new EGUs) outside of Texas. Any potential growth, however, would need to be within the CSAPR emissions cap limitations; the TCEQ modeled the overall CSAPR cap. Alternatives to the TCEQ's approach that include growth and controls are EGU emission projection tools such as the EPA's IPM or the ERTAC EGU projection tool, as introduced in Section 2.3.3.1 above. A comparison was made of the total state emissions predicted by IPM and ERTAC for 2017 to the TCEQ's method, which uses previous version of the CSAPR caps. Table 2-19: *Comparison of Regional (non-Texas) EGU Projections* shows that using CSAPR caps alone yields higher emissions than the IPM or the ERTAC projection tool.

**Table 2-19: Comparison of Regional (non-Texas) EGU Projections**

Source	Ozone Season Average NO <sub>x</sub> (tpd)
TCEQ-applied CSAPR	4433
EPA Platform v6.2 (IPM)	4067
ERTAC v2.5	3773

Table 2-20: *2017 CSAPR Modeled NO<sub>x</sub> Emissions for Other States* provides the 2017 modeled NO<sub>x</sub> emissions (in ozone season average day) along with updated CSAPR cap (ozone) emissions for each state outside Texas in the modeling domain. An empty cell indicates CSAPR is not applicable for that state or that time period. States with no CSAPR cap were modeled at their projection base (2015) emissions. The state allocations of the CSAPR budget are applied (modeled) at the unit level. To assign the budget, the TCEQ identifies the location of each unit via the maintenance of a cross reference file that identifies and locates almost 4000 individual units nationwide; however, there are typically a few units that cannot be matched. In assigning the CSAPR unit caps, over 98% of the CSAPR emissions were matched to individual units. The remaining CSAPR emissions were distributed across all other units throughout the country (non-Texas). This distribution throughout the non-Texas modeling domain may have caused part of one state's CSAPR budget to go to another state, but the redistribution was relatively small and the entire CSAPR model cap was modeled.

**Table 2-20: 2017 CSAPR Modeled NO<sub>x</sub> Emissions for Other States**

State	Ozone Season CSAPR Modelable NO <sub>x</sub> Cap (tons per ozone season)	Annual CSAPR NO <sub>x</sub> Cap (tpy)	2017 May-Sep Average Day NO <sub>x</sub> (tpd)
AL	21901		146.15
AR	12670		83.52
AZ			128.18

State	Ozone Season CSAPR Modelable NO <sub>x</sub> Cap (tons per ozone season)	Annual CSAPR NO <sub>x</sub> Cap (tpy)	2017 May-Sep Average Day NO <sub>x</sub> (tpd)
CA			12.49
CO			104.43
CT			4.18
DC			0.13
DE			4.50
FL			177.90
GA	24041		160.43
IA	12372		82.56
ID			0.99
IL	16259		90.46
IN	39146		261.22
KS	8159		54.42
KY	29147		194.50
LA	19389		122.98
MA			8.74
MD	3915		24.60
ME			0.72
MI	22495		139.17
MN		29572	197.3
MO	19513		129.67
MS	6464		43.13
MT			46.84
NC		41553	277.19
ND			122.81
NE		30039	200.42
NH			2.73
NJ	2125		10.62
NM			130.31
NV			15.69
NY	5691		32.35
OH	29064		192.78
OK	14410		95.96
OR			11.47
PA	39903		251.72
RI			1.85
SC		32498	216.86

State	Ozone Season CSAPR Modelable NO <sub>x</sub> Cap (tons per ozone season)	Annual CSAPR NO <sub>x</sub> Cap (tpy)	2017 May-Sep Average Day NO <sub>x</sub> (tpd)
SD			5.58
TN	9515		63.49
UT			129.41
VA	9743		63.75
VT			0.34
WA			20.17
WI	9320		61.94
WV	28889		187.04
WY			118.28

#### 2.3.4.2 Non-EGUs

For 2017 non-EGUs for other states, the TCEQ used the EPA's 2017 non-IPM (non-EGU) files from its 2011 version 6.2 Modeling Platform. The non-IPM portion of the platform consists of several emissions files including the primary point sources file containing emissions for all states, plus additional files for ethanol and biodiesel plants and cement kilns. After extracting Texas from the list, the TCEQ generated an AFS-formatted file, including all necessary and relevant modeling parameters for EPS3 processing. The associated temporal allocation file was used to create the daily temporal distribution. Summary files provided by the EPA contain individual state totals for non-EGU (non-IPM) emissions. These summaries can be found at the [EPA Emissions Inventory](ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/) website at <ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/>.

Table 2-21: 2017 Regional States Ozone Season Average Emissions Summary provides an overall summary of the 2017 emissions for the non-Texas states within the modeling domain.

**Table 2-21: 2017 Regional States Ozone Season Average Emissions Summary**

Model Year	Source Category	NO <sub>x</sub> Emissions (tpd)	VOC Emissions (tpd)	CO Emissions (tpd)
2017 CSAPR Future Case	EGU	4432	84	1597
2017 EPA Future Case	non-EGU	3301	2256	5200

#### 2.3.5 Offshore, Mexico, and Canada

The 2017 EI for the Gulf of Mexico offshore is the same as was used in the baseline and base case using the 2011 GWEI. An average day, for each of the months modeled was used. For lack of projection data for this sector of the future case EI, the 2011 GWEI was assumed to represent 2017. Additionally, as noted in Section 2.1.2.3, the BOEM indicated that offshore production fell significantly from 2011 to 2014, and the BOEM will use the 2011 GWEI as a typical year in its NAAQS Air Quality Modeling in the

Gulf of Mexico Region Study. The TCEQ used the EPA's 2011 Modeling Platform for Mexico. The platform provided a 2018 case with emissions projected using ERG growth factors, which the TCEQ used without backcasting to 2017. The TCEQ used the 2010 Canadian EI from the EPA's 2011 Modeling Platform for the future case, and did not project it to 2017. This same file was used in the baseline and base case; it is an update from the 2006 EI used in previous SIP revisions,

### 2.3.6 Summary of Future Case Point Source Data Files

The point source emission files that were processed with EPS3 for CAMx are presented in Table 2-22: *AFS Files for the 2017 Future Case*. The regional AFS file for the GWEI contains monthly emissions for the year, the regional AFS file for Canada contains daily emissions that are representative for the entire year, and the regional non-EGU NEI AFS file contains annual emissions. The [2017 future case point source files](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/point/) are available at

[ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/point/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/point/).

**Table 2-22: AFS Files for the 2017 Future Case**

Area	AFS Point Source Emissions Dataset	Record Type
Texas	afs.amp_MAY_2017_average_CSAP_RPOLcp_v3	Hourly
Texas	afs.amp_JUN_2017_average_CSAP_RPOLcp_v3	Hourly
Texas	afs.amp_JUL_2017_average_CSAP_RPOLcp_v3	Hourly
Texas	afs.amp_AUG_2017_average_CSAP_RPOLcp_v3	Hourly
Texas	afs.amp_SEP_2017_average_CSAP_RPOLcp_v3	Hourly
Texas	afs.amp_MAY_2017_average_MECT_RPOLcp_v3	Hourly
Texas	afs.amp_JUN_2017_average_MECT_RPOLcp_v3	Hourly
Texas	afs.amp_JUL_2017_average_MECT_RPOLcp_v3	Hourly
Texas	afs.amp_AUG_2017_average_MECT_RPOLcp_v3	Hourly
Texas	afs.amp_SEP_2017_average_MECT_RPOLcp_v3	Hourly
Texas	afs.osd_no_controls_grown_to_2017.RPOLcp_v12	Daily
Texas	afs.2017_HECT_cap_n_trade_HarrisCo_2014_basis_all_pts_v4	Daily
Texas	afs.osd_hgb_dfw_growth_with_bank_v18	Daily
Texas	afs.osd_CSAP_new_egus_2013_to_2017_all_pols_v4	Daily
Texas	afs.osd_mect_2017_based_on_2014_RPOLcp.v4	Daily
Texas	afs.midlokilns_2017_NO <sub>x</sub> emissions.RPOLcp.v2	Daily
Regional	afs.amp_USA_MAY_2017_average_all_pols_RPOLcp.v2	Hourly
Regional	afs.amp_USA_JUN_2017_average_all_pols_RPOLcp.v2	Hourly
Regional	afs.amp_USA_JUL_2017_average_all_pols_RPOLcp.v2	Hourly
Regional	afs.amp_USA_AUG_2017_average_all_pols_RPOLcp.v2	Hourly
Regional	afs.amp_USA_SEP_2017_average_all_pols_RPOLcp.v2	Hourly
Regional	afs.2017_USA_noTX_noEGU_v3.RPOLcp	Annual
Regional	afs.gwei.2011.lcpRPO	Monthly



Area	AFS Point Source Emissions Dataset	Record Type
Regional	afs.Mexico_2018_from_EPA2011Platform_1999NEI.RPOLcp	Daily
Regional	afs.2010CanadaCB05species.RPOLcp and afs.2010Canada_noCB05species.RPOLcp	Annual

Table 2-23: *2017 Future Case Point Source Emissions Summary – August Average* summarizes the future case emissions. The tabulated emissions are AFS totals input to EPS3. CAMx input VOC values may differ slightly due to chemical mechanism conversions. The “Rest of Texas” column includes some points in Texas outside the 4 km modeling domain, but all of Texas is within the 36 km domain. As noted in Section 2.1.1.4, VOC emission totals include acetone and ethane.

**Table 2-23: 2017 Future Case Point Source Emissions Summary – August Average**

Emission Source	HGB NO <sub>x</sub> (tpd)	HGB VOC (tpd)	Rest of Texas NO <sub>x</sub> (tpd)	Rest of Texas VOC (tpd)	Regional NO <sub>x</sub> (tpd)	Regional VOC (tpd)
non-EGUs	99.9	135.7	428.3	363.9	3301.5	2256.0
EGUs	45.9	2.1	383.5	16.4	4206.9	80.6

## 2.4 2017 POINT SOURCE CONTROL STRATEGY AND/OR SENSITIVITY ANALYSES

As part of this SIP revision, a sensitivity analysis was conducted to estimate the impact of potential ERCs in HGB on the future design value. The sensitivity was conducted by adding 1,317.4 tpy of additional NO<sub>x</sub> reductions to the 275.2 tpy certified HGB NO<sub>x</sub> ERCs extracted from the EBT Credit Registry on September 16, 2016. Similarly, an additional 2,851.6 tpy of VOC reductions were added to the 784.5 tpy of certified HGB VOC ERCs extracted from the EBT Credit Registry on September 16, 2016. The potential ERCs were processed using the same method as certified ERCs to obtain the 2017 modelable bank. The potential ERCs increased modelable HGB NO<sub>x</sub> ERCs from 0.6 tpd to 3.4 tpd and modelable HGB VOC ERCs from 1.7 tpd to 7.7 tpd. All other aspects of the modelable bank remained the same as described in Table 2-15. The new modelable bank was compared to the predicted growth values for 2017 as described above. The predicted growth values for HGB 2017 VOC emissions were greater than the modelable HGB VOC ERCs (9.33 tpd compared to 7.7 tpd, respectively). However, the predicted growth values for HGB 2017 NO<sub>x</sub> emissions were smaller than the modelable HGB NO<sub>x</sub> ERCs (1.98 tpd compared to 3.4 tpd, respectively). Since the goal of the sensitivity was to determine the impact of the potential ERCs, the 2017 future case NO<sub>x</sub> emissions were modeled at the 3.4 tpd.

## CHAPTER 3: ON-ROAD MOBILE SOURCE MODELING EMISSIONS DEVELOPMENT

### 3.1 ON-ROAD MOBILE SOURCE EMISSIONS INVENTORIES FOR EIGHT-COUNTY HGB

This section provides a brief overview of the development of the HGB eight-county area on-road mobile source emissions inventory files that were input into the photochemical model for the 2012 base case, the 2012 baseline case, and the 2017

future case. The 2012 on-road emission inventories were developed with the 2014 version of the Motor Vehicle Emission Simulator (MOVES2014) model, while the 2017 inventories were developed at a later date with the updated [MOVES2014a version](https://www.epa.gov/moves), which can be obtained at <https://www.epa.gov/moves>. The on-road emissions inventory datasets were developed under contract by the Texas Transportation Institute (TTI). TTI developed 2012 and 2017 on-road emission estimates using MOVES2014/MOVES2014a and vehicle miles traveled (VMT) estimates from the travel demand model (TDM) managed by the Houston-Galveston Area Council (H-GAC).

Both MOVES2014 and MOVES2014a output nitrogen oxide (NO), nitrogen dioxide (NO<sub>2</sub>), and nitrous acid (HONO), which are components of oxides of nitrogen (NO<sub>x</sub>). The tables in this section report NO, NO<sub>2</sub>, and NO<sub>x</sub> separately. Due to space limitations, HONO is not reported separately, but MOVES2014 and MOVES2014a calculate it as 0.8% of total NO<sub>x</sub> emissions. For both the 2012 base case and the 2017 future case, school and summer season on-road emission inventories were developed for the four day types of weekday (i.e., Monday through Thursday average, Friday, Saturday, and Sunday). For the on-road category, base case and baseline emissions are the same.

Table 3-1: *VMT and Emissions by Day Type for 2012 HGB On-Road Inventory* and Table 3-2: *VMT and Emissions by Day Type for 2017 HGB On-Road Inventory* provide summaries of the total VMT, NO, NO<sub>2</sub>, NO<sub>x</sub>, volatile organic compounds (VOC), and carbon monoxide (CO) emissions for the eight-county HGB area for each day type for the 2012 base case and 2017 future case, respectively. As shown, Fridays have the highest total VMT of the week, while Saturdays and Sundays have the lowest total daily VMT. While overall VMT increases with future growth, total emissions decrease from 2012 to 2017 because of more stringent emissions standards for newer vehicles entering the fleet, combined with the simultaneous attrition of older, higher-emitting vehicles. Consistent with current federal and state rules, the on-road inventories from TTI include the benefits of:

- reformulated gasoline (RFG) in all eight HGB area counties;
- the inspection and maintenance (I/M) Program in Brazoria, Fort Bend, Galveston, Harris, and Montgomery counties; and
- Texas low emission diesel (TxLED) fuel for all eight HGB area counties.

**Table 3-1: VMT and Emissions by Day Type for 2012 HGB On-Road Inventory**

Season and Day Type	Vehicle Miles Traveled	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	149,280,642	140.64	15.19	157.09	73.60	835.49
Summer Friday	161,408,283	147.10	16.06	164.47	75.49	887.39
Summer Saturday	130,382,880	111.72	12.10	124.82	64.39	715.90
Summer Sunday	108,366,437	92.62	9.80	103.24	60.56	629.11
School Weekday	150,120,658	141.09	15.25	157.61	73.74	838.96
School Friday	163,383,425	148.29	16.21	165.83	75.84	895.72
School Saturday	129,005,457	110.53	11.96	123.47	64.17	710.78
School Sunday	107,370,403	91.72	9.69	102.23	60.39	625.45

**Table 3-2: VMT and Emissions by Day Type for 2017 HGB On-Road Inventory**

Season and Day Type	Vehicle Miles Traveled	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	167,839,692	82.81	11.98	95.56	54.40	708.52
Summer Friday	181,223,706	85.70	12.45	98.94	55.33	751.20
Summer Saturday	146,210,202	65.13	9.06	74.79	48.45	605.95
Summer Sunday	121,485,118	54.36	7.18	62.03	46.33	535.10
School Weekday	171,518,855	84.16	12.21	97.15	54.71	719.81
School Friday	186,898,470	87.63	12.79	101.23	55.80	768.84
School Saturday	148,316,912	65.65	9.15	75.41	48.59	612.82
School Sunday	123,605,770	54.86	7.26	62.62	46.47	541.92

Even though all of the day type on-road inventory datasets were used for photochemical model input, only the summer weekday emissions are detailed here. For the 2012 base case and 2017 future case, the summaries of the VMT, NO, NO<sub>2</sub>, NO<sub>x</sub>, VOC, and CO emissions for each of the eight counties in the HGB area are shown in Table 3-3: *VMT and Emissions by County for 2012 HGB On-Road Inventory* and Table 3-4: *VMT and Emissions by County for 2017 HGB On-Road Inventory*, respectively.

**Table 3-3: VMT and Emissions by County for 2012 HGB On-Road Inventory**

HGB Area County	Vehicle Miles Traveled	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Brazoria	6,140,967	6.54	0.66	7.26	3.78	38.35
Chambers	2,647,936	5.67	0.60	6.32	1.04	13.92
Fort Bend	9,650,305	9.03	0.95	10.07	5.65	55.20
Galveston	5,800,789	5.26	0.54	5.84	3.42	36.17
Harris	108,923,195	95.83	10.48	107.17	51.40	600.19
Liberty	2,221,987	3.70	0.38	4.11	1.47	15.10
Montgomery	11,892,306	11.60	1.25	12.95	5.78	63.49
Waller	2,003,157	3.01	0.33	3.37	1.06	13.07
Total	149,280,642	140.64	15.19	157.09	73.60	835.49

**Table 3-4: VMT and Emissions by County for 2017 HGB On-Road Inventory**

HGB Area County	Vehicle Miles Traveled	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Brazoria	8,047,857	4.39	0.57	4.99	3.27	37.61
Chambers	3,217,165	3.85	0.62	4.51	0.76	12.35
Fort Bend	13,198,265	6.60	0.96	7.62	5.32	58.05
Galveston	6,157,335	2.91	0.38	3.31	2.40	28.95
Harris	117,215,490	53.33	7.68	61.50	35.93	487.25
Liberty	2,632,844	2.28	0.32	2.62	1.11	13.02
Montgomery	15,475,728	7.86	1.18	9.11	4.96	62.37
Waller	1,895,008	1.59	0.27	1.88	0.65	8.92

HGB Area County	Vehicle Miles Traveled	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Total	167,839,692	82.81	11.98	95.56	54.40	708.52

Summaries for 2012 and 2017 of the VMT, NO, NO<sub>2</sub>, NO<sub>x</sub>, VOC, and CO emissions for the gasoline and diesel fuel source use type (SUT) combinations from the MOVES model are presented in Table 3-5: *VMT and Emissions by Vehicle Type for 2012 HGB On-Road Inventory* and Table 3-6: *VMT and Emissions by Vehicle Type for 2017 HGB On-Road Inventory*.

**Table 3-5: VMT and Emissions by Vehicle Type for 2012 HGB On-Road Inventory**

Fuel and Source Use Type Combination	VMT	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Gasoline - Motorcycle	108,860	0.07	0.00	0.07	0.82	1.66
Gasoline - Passenger Car	108,209,960	41.31	4.78	46.46	36.77	440.54
Gasoline - Passenger Truck	23,276,540	24.43	2.53	27.18	20.72	235.58
Gasoline - Light Commercial Truck	5,794,423	6.73	0.70	7.50	5.59	65.85
Gasoline - School Bus	2,202	0.01	0.00	0.01	0.01	0.12
Gasoline - Refuse Truck	77,988	0.42	0.03	0.45	0.20	5.13
Gasoline - Single Unit Short-Haul Truck	1,487,849	2.93	0.21	3.16	1.37	32.32
Gasoline - Single Unit Long-Haul Truck	280,361	0.50	0.04	0.54	0.22	5.10
Gasoline - Motor Home	59,337	0.20	0.01	0.21	0.09	1.93
Gasoline - Combination Short-Haul Truck	201,758	0.79	0.05	0.85	0.30	9.42
Diesel - Passenger Car	434,706	0.19	0.02	0.20	0.23	4.03
Diesel - Passenger Truck	330,409	0.79	0.08	0.88	0.28	3.24
Diesel - Light Commercial Truck	330,423	0.89	0.08	0.98	0.30	2.91
Diesel - Intercity Bus	179,824	2.19	0.17	2.38	0.17	0.82
Diesel - Transit Bus	74,007	0.64	0.05	0.70	0.06	0.35
Diesel - School Bus	231,147	1.27	0.10	1.38	0.24	0.77
Diesel - Refuse Truck	135,068	1.20	0.12	1.32	0.09	0.50
Diesel - Single Unit Short-Haul Truck	2,586,048	7.10	1.04	8.21	1.25	5.15
Diesel - Single Unit Long-Haul Truck	474,607	1.20	0.18	1.39	0.22	0.90
Diesel - Motor Home	102,210	0.52	0.04	0.56	0.10	0.29
Diesel - Combination Short-Haul Truck	2,441,335	18.27	1.96	20.39	1.35	7.21
Diesel - Combination Long-Haul Truck	2,461,581	29.00	3.02	32.27	3.21	11.68
Total	149,280,642	140.64	15.19	157.09	73.60	835.49

**Table 3-6: VMT and Emissions by Vehicle Type for 2017 HGB On-Road Inventory**

Fuel and Source Use Type Combination	VMT	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Gasoline - Motorcycle	117,592	0.07	0.00	0.07	0.88	1.54
Gasoline - Passenger Car	116,544,133	20.38	2.13	22.70	28.53	381.92
Gasoline - Passenger Truck	30,025,026	14.96	1.49	16.59	15.15	204.31
Gasoline - Light Commercial Truck	7,375,132	4.09	0.41	4.54	4.03	56.94

<b>Fuel and Source Use Type Combination</b>	<b>VMT</b>	<b>NO (tpd)</b>	<b>NO<sub>2</sub> (tpd)</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>
Gasoline - School Bus	3,078	0.01	0.00	0.01	0.01	0.20
Gasoline - Refuse Truck	71,820	0.34	0.02	0.36	0.19	4.47
Gasoline - Single Unit Short-Haul Truck	1,355,461	0.79	0.08	0.88	0.65	22.48
Gasoline - Single Unit Long-Haul Truck	223,410	0.11	0.01	0.13	0.09	3.07
Gasoline - Motor Home	56,501	0.11	0.01	0.11	0.06	1.32
Gasoline - Combination Short-Haul Truck	231,795	0.28	0.03	0.31	0.15	4.73
Diesel - Passenger Car	821,583	0.10	0.03	0.13	0.08	2.79
Diesel - Passenger Truck	518,901	0.77	0.14	0.91	0.21	2.34
Diesel - Light Commercial Truck	404,900	0.63	0.10	0.73	0.19	2.13
Diesel - Intercity Bus	51,945	0.41	0.04	0.46	0.03	0.17
Diesel - Transit Bus	103,491	0.55	0.06	0.62	0.06	0.38
Diesel - School Bus	284,302	1.08	0.11	1.20	0.20	0.85
Diesel - Refuse Truck	123,989	0.57	0.09	0.66	0.04	0.30
Diesel - Single Unit Short-Haul Truck	2,354,475	2.91	0.85	3.79	0.41	2.87
Diesel - Single Unit Long-Haul Truck	377,237	0.42	0.13	0.55	0.06	0.43
Diesel - Motor Home	97,627	0.31	0.04	0.35	0.06	0.19
Diesel - Combination Short-Haul Truck	2,807,414	10.07	1.92	12.09	0.68	4.25
Diesel - Combination Long-Haul Truck	3,889,881	23.84	4.30	28.37	2.65	10.83
Total	167,839,692	82.81	11.98	95.56	54.40	708.52

The MOVES2014 run specification files used to develop the 2012 inventories, along with detailed reports and summary output data, can be found on the [2012 Texas on-road FTP site](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/hgb/mvs14/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/onroad/hgb/mvs14/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/hgb/mvs14/). The MOVES2014a run specification files used to develop the 2017 inventories, along with detailed reports and summary output data, can be found on the [2017 Texas on-road FTP site](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/hgb/mvs14a/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/onroad/hgb/mvs14a/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/hgb/mvs14a/).

### 3.2 ON-ROAD MOBILE SOURCE EMISSIONS PROCESSING

The on-road emissions inventory data provided by TTI were prepared for input into the photochemical model using version 3 of the Emissions Processor System (EPS3). When input into EPS3, the inventory data are in a readable text-based format. However, the emissions data are maintained in a binary format within EPS3. Table 3-7: *EPS3 Modules for Processing On-Road Emissions* summarizes the EPS3 modules that were used to process the eight-county HGB on-road inventories.

**Table 3-7: EPS3 Modules for Processing On-Road Emissions**

EPS3 Module	Description
LBASE	Spatially allocate link-based emissions among grid cells.
PREAM	Prepare non-link “roadway type” emissions for further processing.
PREPNT	Prepare stationary extended idling emissions for further processing.
CNTLEM	Apply controls to model strategies, apply adjustments, etc.
TMPRL	Apply temporal profiles to extended idling emissions.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
GRDEM	Sum emissions by grid cell for photochemical model input.
MARGUAM	Merge and adjust multiple gridded files for photochemical model input.

The MOVES2014a model only estimates extended idling emissions for the diesel fuel combination long-haul truck category. Using a combination of SAS and LINUX code, the extended idling emissions were aggregated into an eight-county total and spatially assigned to known truck stop locations. The extended idling emissions were then processed through EPS3 as if they were stationary low-level point sources. The summer weekday extended idling emissions by county are presented below in Table 3-8: *2012 and 2017 HGB Area Long-Haul Truck Extended Idling Emissions*. Greater detail on heavy-duty vehicle idling activity specific to Texas metropolitan areas can be found in a report entitled [Heavy-Duty Vehicle Idle Activity and Emissions Characterization Study](http://www.tceq.texas.gov/airquality/airmod/project/pj_report_mob.html), which is available at [http://www.tceq.texas.gov/airquality/airmod/project/pj\\_report\\_mob.html](http://www.tceq.texas.gov/airquality/airmod/project/pj_report_mob.html).

**Table 3-8: 2012 and 2017 HGB Area Long-Haul Truck Extended Idling Emissions**

Calendar Year	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
2012	5.09	0.77	5.91	1.74	3.06
2017	4.73	1.46	6.24	1.48	3.43

### 3.2.1 Texas Low Emission Diesel Fuel Benefits

Based on the EPA memorandum [Texas Low Emission Diesel \(LED\) Fuel Benefits](#) (September 27, 2001), a 4.8% NO<sub>x</sub> TxLED reduction should be claimed for 2002-and-newer diesel vehicles and a 6.2% NO<sub>x</sub> TxLED reduction should be claimed for 2001-and-older diesel vehicles. In order to determine the specific TxLED adjustment factors that should apply to each of the twelve diesel fuel source use types, MOVES2014a model runs were performed to determine NO<sub>x</sub> emissions rates by model year. By using these data, the 4.8% and 6.2% TxLED reduction factors were weighted according to the model year specific diesel NO<sub>x</sub> emission rates. The [TxLED factors FTP site](http://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/](http://amdaftp.tceq.texas.gov/pub/EI/onroad/txled/) contains more detail on this analysis. The resulting TxLED adjustment factors and benefits for both 2012 and 2017 are summarized in Table 3-9: *2012 HGB On-Road TxLED Benefits by Vehicle Type* and Table 3-10: *2017 HGB On-Road TxLED Benefits by Vehicle Type*, respectively. The TxLED adjustment factors were incorporated by TTI into the on-road inventories by post-processing the MOVES2014a diesel fuel source use type NO<sub>x</sub> emission rates.

**Table 3-9: 2012 HGB On-Road TxLED Benefits by Vehicle Type**

<b>Diesel Fuel Source Use Type</b>	<b>NO<sub>x</sub> Reduction</b>	<b>Adjustment Factor</b>	<b>NO<sub>x</sub> Benefit (tpd)</b>
Passenger Car	5.87%	0.9413	0.01
Passenger Truck	5.34%	0.9466	0.05
Light Commercial Truck	5.66%	0.9434	0.06
Intercity Bus	5.84%	0.9416	0.15
Transit Bus	5.81%	0.9419	0.04
School Bus	5.80%	0.9420	0.08
Refuse Truck	5.62%	0.9438	0.08
Single Unit Short-Haul Truck	5.07%	0.9493	0.44
Single Unit Long-Haul Truck	5.00%	0.9500	0.07
Motor Home	5.57%	0.9443	0.03
Combination Short-Haul Truck	5.48%	0.9452	1.18
Combination Long-Haul Truck	5.55%	0.9445	1.90
<b>Total</b>			<b>4.10</b>

**Table 3-10: 2017 HGB On-Road TxLED Benefits by Vehicle Type**

<b>Diesel Fuel Source Use Type</b>	<b>NO<sub>x</sub> Reduction</b>	<b>Adjustment Factor</b>	<b>NO<sub>x</sub> Benefit (tpd)</b>
Passenger Car	5.17%	0.9483	0.01
Passenger Truck	5.08%	0.9492	0.05
Light Commercial Truck	5.35%	0.9465	0.04
Intercity Bus	5.69%	0.9431	0.03
Transit Bus	5.66%	0.9434	0.04
School Bus	5.67%	0.9433	0.07
Refuse Truck	5.38%	0.9462	0.04
Single Unit Short-Haul Truck	4.89%	0.9511	0.19
Single Unit Long-Haul Truck	4.90%	0.9510	0.03
Motor Home	5.38%	0.9462	0.02
Combination Short-Haul Truck	5.19%	0.9481	0.66
Combination Long-Haul Truck	5.26%	0.9474	1.58
<b>Total</b>			<b>2.75</b>

### 3.3 ON-ROAD MOBILE EIGHT-COUNTY HGB PHOTOCHEMICAL MODELING INPUT

The summer weekday on-road emissions by county that were input into the photochemical model are summarized below in Table 3-11: *2012 HGB Area Summer Weekday On-Road Emissions by County* and Table 3-12: *2017 HGB Area Summer Weekday On-Road Emissions by County*. These on-road inventory summaries are a combination of running exhaust, evaporative, off-network, and extended idling emissions. Differences by individual counties between these figures and those referenced above in Table 3-3 and Table 3-4 are due to the spatial reallocation of

extended idling emissions presented above in Table 3-8. However, the eight-county total on-road emission estimates do not differ.

**Table 3-11: 2012 HGB Area Summer Weekday On-Road Emissions by County**

HGB Area County	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Brazoria	6.54	0.66	7.26	3.78	38.35
Chambers	5.67	0.60	6.32	1.04	13.92
Fort Bend	9.01	0.95	10.04	5.65	55.19
Galveston	5.26	0.54	5.85	3.43	36.18
Harris	95.79	10.48	107.12	51.38	600.14
Liberty	3.70	0.38	4.12	1.47	15.09
Montgomery	11.53	1.24	12.87	5.76	63.35
Waller	3.10	0.35	3.48	1.09	13.14
Total	140.64	15.19	157.09	73.60	835.49

**Table 3-12: 2017 HGB Area Summer Weekday On-Road Emissions by County**

HGB Area County	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Brazoria	4.38	0.56	4.98	3.27	37.60
Chambers	3.82	0.62	4.47	0.75	12.33
Fort Bend	6.47	0.92	7.45	5.28	57.95
Galveston	2.92	0.38	3.33	2.40	28.96
Harris	53.51	7.73	61.73	35.98	487.37
Liberty	2.28	0.32	2.63	1.11	13.03
Montgomery	7.75	1.15	8.97	4.93	62.29
Waller	1.68	0.30	1.99	0.68	8.99
Total	82.81	11.98	95.56	54.40	708.52

The total eight-county HGB on-road emissions input to the photochemical model by day type are summarized in Table 3-13: *2012 HGB Area On-Road Emissions by Season and Day Type* and Table 3-14: *2017 HGB Area On-Road Emissions by Season and Day Type*. Slight differences by day type between these figures and those presented in Table 3-1 and Table 3-2 are due to the on-road emission inventories being developed in Central Daylight Time (CDT), but processed for photochemical model input in Central Standard Time (CST). For example, the 11 PM - 12 AM CST emissions on a Friday evening are based on 12-1 AM CDT emissions from a Saturday.

**Table 3-13: 2012 HGB Area On-Road Emissions by Season and Day Type**

Season and Day Type	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	140.64	15.19	157.09	73.60	835.49
Summer Friday	147.70	16.11	165.13	75.77	893.23
Summer Saturday	111.67	12.09	124.76	64.38	716.55



Season and Day Type	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Summer Sunday	91.96	9.73	102.52	60.26	622.00
School Weekday	141.09	15.25	157.61	73.74	838.96
School Friday	148.82	16.26	166.41	76.10	901.30
School Saturday	110.53	11.96	123.47	64.17	711.73
School Sunday	91.07	9.63	101.51	60.10	618.31

**Table 3-14: 2017 HGB Area On-Road Emissions by Season and Day Type**

Season and Day Type	NO (tpd)	NO <sub>2</sub> (tpd)	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)
Summer Weekday	82.81	11.98	95.56	54.40	708.52
Summer Friday	85.95	12.43	99.18	55.51	756.03
Summer Saturday	65.07	9.04	74.71	48.43	606.58
Summer Sunday	54.14	7.21	61.85	46.15	529.42
School Weekday	84.16	12.21	97.15	54.71	719.81
School Friday	87.84	12.76	101.42	55.97	773.56
School Saturday	65.64	9.14	75.38	48.59	613.83
School Sunday	54.64	7.29	62.43	46.30	535.99

The EPS3 message files for 2012 HGB along with the gridded photochemical model input files are available on the [HGB 2012 on-road FTP site](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/hgb/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/onroad/hgb/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/hgb/). The EPS3 message files for 2017 HGB along with the gridded photochemical model input files are available on the [HGB 2017 on-road FTP site](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/hgb/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/onroad/hgb/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/hgb/).

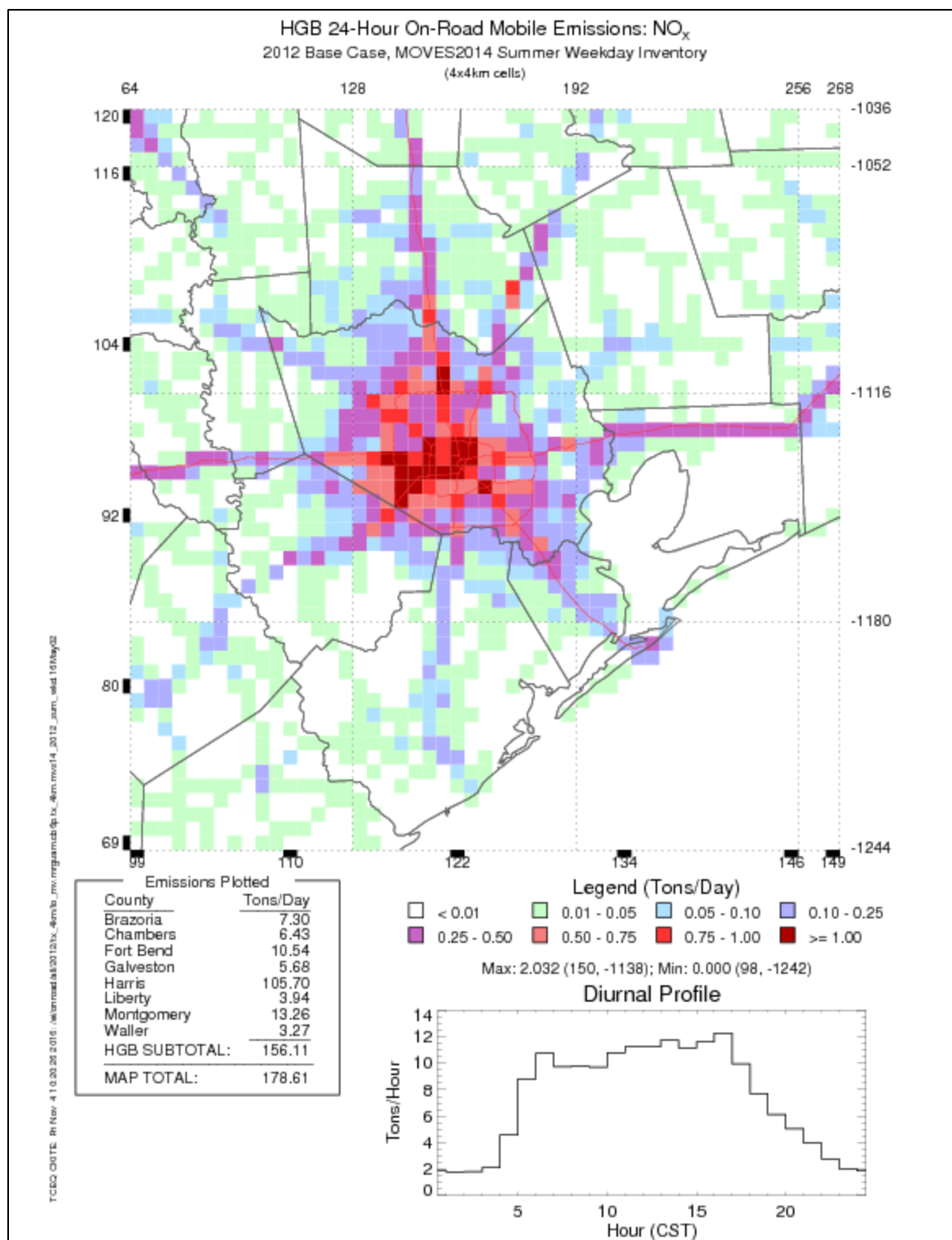
### 3.4 ATTAINMENT DEMONSTRATION MOTOR VEHICLE EMISSIONS BUDGET

By definition, the future case on-road NO<sub>x</sub> and VOC emission estimates input into the final attainment demonstration photochemical modeling run establish the motor vehicle emissions budget (MVEB). The 2017 summer weekday on-road emissions are the most representative season and day type for this purpose, and are presented below in Table 3-15: *Attainment Demonstration MVEB for the Eight-County HGB Area*. As shown, these 2017 figures match those provided by TTI as summarized above in Table 3-2, Table 3-4, and Table 3-6. No emission reduction credits were taken for local transportation control measures (TCMs) or voluntary mobile source emission reduction program (VMEP) strategies.

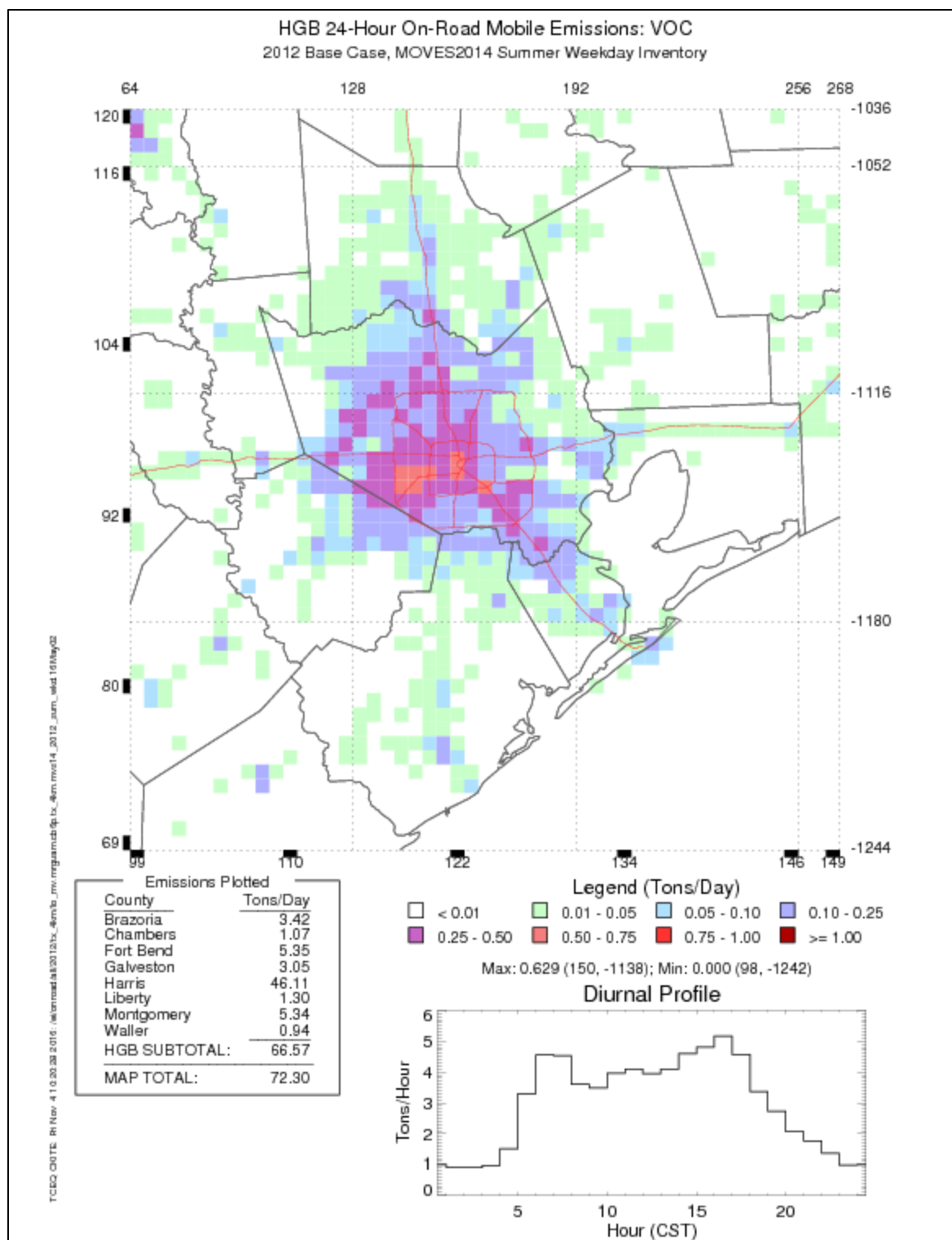
**Table 3-15: Attainment Demonstration MVEB for the Eight-County HGB Area**

Eight-County HGB Area On-Road Emissions	NO <sub>x</sub> (tpd)	VOC (tpd)
<b>2017 On-Road Inventory From TTI (Table 3-2)</b> Includes RFG, Low RVP, I/M, and TxLED	95.56	54.40

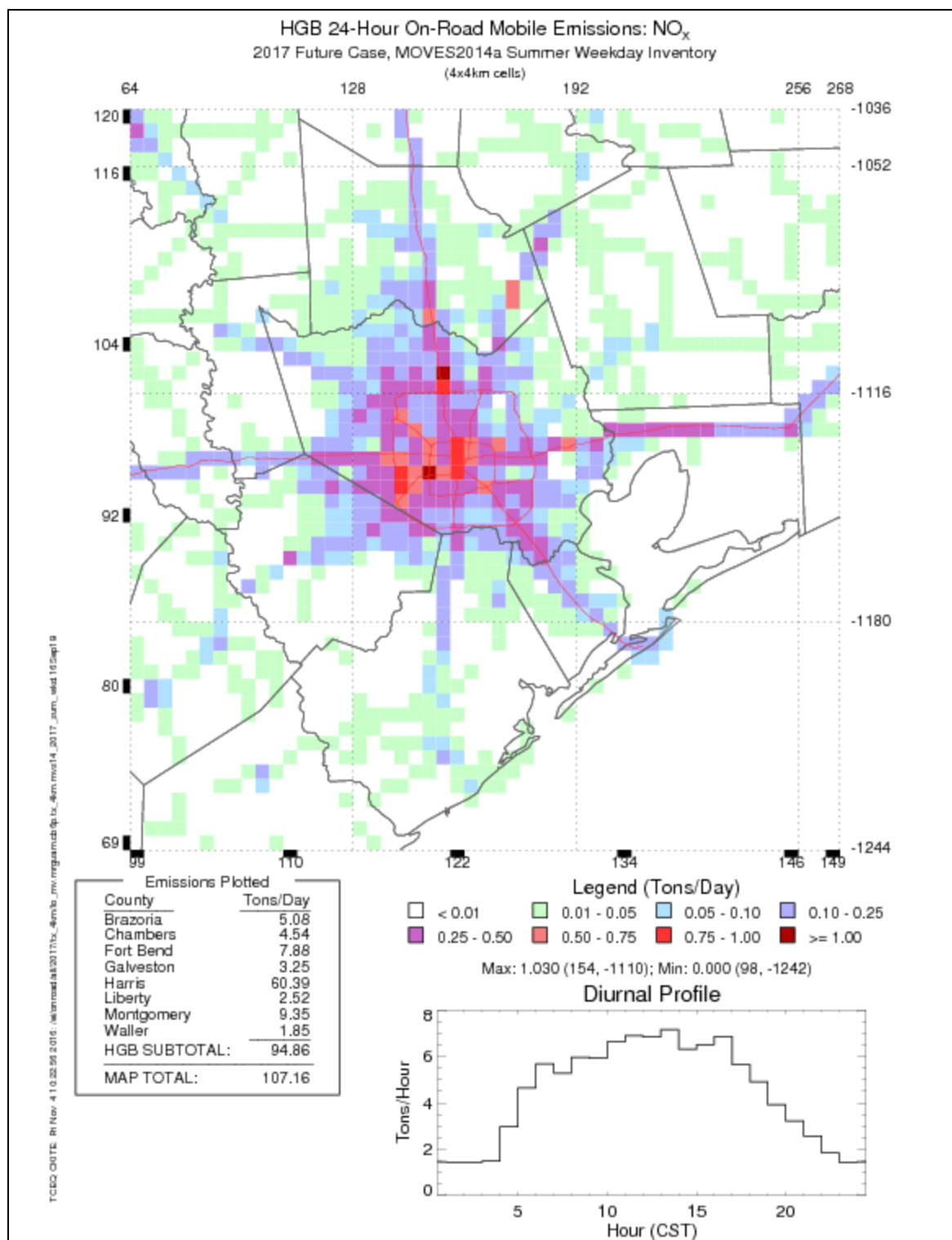
The following pages contain graphical plots of the spatial and temporal distribution of 2012 and 2017 on-road summer weekday NO<sub>x</sub> and VOC emissions for the HGB area. The plots show that the morning rush hour peak is appropriately allocated to 6-7 AM CST, which is 7-8 AM CDT. These plots are respectively entitled Figure 3-1: *2012 Summer Weekday HGB On-Road NO<sub>x</sub> Emissions Distribution*, Figure 3-2: *2012 Summer Weekday On-Road VOC Emissions Distribution*, Figure 3-3: *2017 Summer Weekday On-Road NO<sub>x</sub> Emissions Distribution*, and Figure 3-4: *2017 Summer Weekday On-Road VOC Emissions Distribution*.



**Figure 3-1: 2012 Summer Weekday HGB On-Road NO<sub>x</sub> Emissions Distribution**



**Figure 3-2: 2012 Summer Weekday On-Road VOC Emissions Distribution**



**Figure 3-3: 2017 Summer Weekday On-Road NO<sub>x</sub> Emissions Distribution**



### 3.5 ON-ROAD MOBILE SOURCE EMISSIONS INVENTORIES FOR NON-HGB AREAS

For the Texas counties outside of the HGB area, on-road emissions were developed by TTI using HPMS data as the basis for VMT estimates. Both school and summer season emission estimates were developed for the four day types of weekday, Friday, Saturday, and Sunday. Hourly emission rates from MOVES2014 were coupled with county-level VMT estimates by roadway type for 2012 and 2017. More detail on the development of these HPMS-based on-road datasets can be found on the [Texas 2012 on-road FTP site](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/tex/) and [Texas 2017 on-road FTP site](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/tex/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/onroad/tex/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/tex/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/onroad/tex/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/tex/), respectively.

On-road emission estimates for non-Texas states within the photochemical modeling domain were developed for both 2012 and 2017 using MOVES2014 model default runs. For 2012 and 2017, default on-road emissions were estimated for the July weekday option available with MOVES2014. These summer weekday emission totals were then adjusted with EPS3 to obtain inputs for the other season and day type combinations. More detail on the development of the MOVES2014 on-road datasets can be found on the [U.S. 2012 on-road FTP site](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/usa/) and the [U.S. 2017 on-road FTP site](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/usa/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/onroad/usa/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/onroad/usa/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/onroad/usa/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/onroad/usa/), respectively.

A summary of the different on-road emission estimation approaches by geographic area for this HGB SIP revision is provided in Table 3-16: *On-Road Inventory Development Methodologies by Geographic Area*.

**Table 3-16: On-Road Inventory Development Methodologies by Geographic Area**

<b>On-Road Inventory Development Parameter</b>	<b>HGB Area</b>	<b>Non-HGB Texas Counties</b>	<b>Non-Texas States and Counties</b>
VMT Source	TDM	HPMS	MOVES2014 Defaults
VMT Resolution	TDM Roadway "Link" Segments	19 Roadway Types	12 Roadway Types
Season Types	School and Summer	School and Summer	School and Summer
Day Types	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday	Weekday, Friday, Saturday, and Sunday
Hourly Variation in VMT?	Yes	Yes	Yes
Roadway Speed Distribution	Varies by Hour and Roadway Link	Varies by Hour and Roadway Type	MOVES2014 Defaults
Spatial Resolution	Excellent	Very Good	Good
Temporal Resolution	Excellent	Very Good	Good

On-Road Inventory Development Parameter	HGB Area	Non-HGB Texas Counties	Non-Texas States and Counties
MOVES Fuel and Source Use Types	Gasoline and Diesel 13 Source Use Types	Gasoline and Diesel 13 Source Use Types	Gasoline and Diesel 13 Source Use Types

## CHAPTER 4: NON-ROAD, OFF-ROAD, AND AREA SOURCE MODELING EMISSIONS

### 4.1 OIL AND GAS PRODUCTION AND DRILLING EMISSIONS INVENTORY DEVELOPMENT

Oil and gas production emission estimates were developed based on activity data from the [Railroad Commission of Texas \(RRC\)](#) multiplied by emission factors for specific operations and types of equipment from an Eastern Research Group (ERG) study, [Characterization of Oil and Gas Production Equipment and Develop a Methodology to Estimate Statewide Emissions](#). This report is available on the [TCEQ Air Quality Research and Contracts Reports: Emissions Inventory web page](#) at [http://www.tceq.texas.gov/airquality/airmod/project/pi\\_report\\_ei.html](http://www.tceq.texas.gov/airquality/airmod/project/pi_report_ei.html). Activity data from the RRC specific to 2012 and 2014 were obtained for production of natural gas, crude oil, and condensate, along with additional parameters such as the total number of operational gas wells, operational oil wells, etc. These activity figures were multiplied by emission factors from the ERG study to obtain oil and gas production emission estimates. For example, compressor engine emissions are a function of natural gas production, so compressor engine emission rates were multiplied by total natural gas produced. Condensate storage tank emission estimates were calculated as a function of condensate production. In a similar manner, emissions from crude oil storage tanks are a function of crude oil production. The ERG study contains a summary of how each calculation is performed. The 2012 oil and gas production emission estimates for the eight-county HGB area are summarized in Table 4-1: *2012 HGB Area Oil and Gas Production Emissions by Equipment Type*. Emission estimates for nitrogen oxides (NO<sub>x</sub>), volatile organic compounds (VOC), carbon monoxide (CO), sulfur dioxide (SO<sub>2</sub>), and particulate matter with a mean diameter of 2.5 microns (PM<sub>2.5</sub>) are provided.

**Table 4-1: 2012 HGB Area Oil and Gas Production Emissions by Equipment Type**

Oil and Gas Production Equipment	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Artificial Lift	0.99	0.01	1.54	0.00	0.01
Heater Treater	0.40	0.04	0.58	0.00	0.05
Hydraulic Fracturing Engines	0.34	0.02	0.07	0.00	0.01
Natural Gas Fired Four-Cycle Rich-Burn Compressor Engines from 50 to 499 Horsepower (HP) w/NSCR	0.21	0.01	0.23	0.00	0.02
Gas Well Heaters	0.05	0.01	0.11	0.00	0.01
Natural Gas Fired Four-Cycle Rich-Burn Compressor Engines less than 50 HP	0.03	0.00	0.00	0.00	0.00
Natural Gas Fired Four-Cycle Lean-Burn Compressor Engines above 500 HP	0.02	0.02	0.13	0.00	0.00
Natural Gas Fired Two-Cycle Lean-Burn Compressor Engines less than 50 HP	0.02	0.00	0.01	0.00	0.00



<b>Oil and Gas Production Equipment</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Total: All Processes	0.02	0.04	0.08	0.13	0.00
Natural Gas Fired Two-Cycle Lean-Burn Compressor Engines from 50 To 499 HP	0.01	0.01	0.01	0.00	0.00
Gas Well Dehydrators	0.00	0.01	0.00	0.00	0.00
Storage Tanks: Condensate	0.00	25.20	0.00	0.00	0.00
Storage Tanks: Crude Oil	0.00	21.99	0.00	0.00	0.00
Produced Water	0.00	4.79	0.00	0.00	0.00
Wellhead	0.00	3.58	0.00	0.00	0.00
Tank Truck/Railcar Loading: Crude Oil	0.00	2.32	0.00	0.00	0.00
Oil Well Completion: All Processes	0.00	1.92	0.00	0.00	0.00
Gas Well Pneumatic Devices	0.00	1.29	0.00	0.00	0.00
Oil Well Pneumatic Devices	0.00	1.22	0.00	0.00	0.00
Tank Truck/Railcar Loading: Condensate	0.00	0.85	0.00	0.00	0.00
Gas Well Pneumatic Pumps	0.00	0.60	0.00	0.00	0.00
Mud Degassing	0.00	0.52	0.00	0.00	0.00
Fugitives: Other	0.00	0.48	0.00	0.00	0.00
Oil Well Pneumatic Pumps	0.00	0.38	0.00	0.00	0.00
Fugitives: Valves	0.00	0.30	0.00	0.00	0.00
Gas Well Venting	0.00	0.25	0.00	0.00	0.00
Fugitives: Other	0.00	0.22	0.00	0.00	0.00
Fugitives: Pumps	0.00	0.17	0.00	0.00	0.00
Fugitives: Connectors	0.00	0.11	0.00	0.00	0.00
Gas Well Completion: All Processes	0.00	0.07	0.00	0.00	0.00
Mud Degassing	0.00	0.07	0.00	0.00	0.00
Fugitives: Flanges	0.00	0.03	0.00	0.00	0.00
Fugitives: Connectors	0.00	0.03	0.00	0.00	0.00
Fugitives: Open Ended Lines	0.00	0.02	0.00	0.00	0.00
Fugitives: Open Ended Lines	0.00	0.02	0.00	0.00	0.00
Fugitives: Pumps	0.00	0.01	0.00	0.00	0.00
Fugitives: Flanges	0.00	0.01	0.00	0.00	0.00
<b>Oil and Gas Production Total</b>	<b>2.09</b>	<b>66.60</b>	<b>2.78</b>	<b>0.14</b>	<b>0.11</b>

2017 future year emission estimates for oil and gas production were projected using 2014 RRC data, which is the latest full year available when this projection was done. Since upstream oil and gas production for the HGB area has been relatively stable over time, the 2014 production emissions were held constant and used as 2017 inputs. In accordance with the recently promulgated OOOO regulations for “green completions” issued by the U.S. EPA, NO<sub>x</sub> and CO emissions associated with gas well completions for 2017 were reduced to zero. This reduced the total 2017 production emissions by 0.01 NO<sub>x</sub> tpd and 0.01 CO tpd to 1.96 NO<sub>x</sub> tpd and 2.85 CO tpd. The 2017 oil and gas production emission estimates for the eight-county HGB area are summarized in Table 4-2: *2017 HGB Area Oil and Gas Production Emissions by Equipment Type*.

**Table 4-2: 2017 HGB Area Oil and Gas Production Emissions by Equipment Type**

<b>Oil and Gas Production Equipment</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Artificial Lift	0.99	0.01	1.53	0.00	0.01
Heater Treater	0.40	0.04	0.58	0.00	0.05
Hydraulic Fracturing Engines	0.20	0.01	0.04	0.00	0.01
Natural Gas Fired Four-Cycle Rich Burn Compressor Engines from 50 to 499 HP with NSCR	0.16	0.01	0.18	0.00	0.01
Gas Well Heaters	0.10	0.01	0.17	0.00	0.01
Natural Gas Fired Four-Cycle Lean-Burn Compressor Engines Above 500 HP	0.03	0.03	0.17	0.00	0.00
Natural Gas Fired Four-Cycle Rich-Burn Compressor Engines less than 50 HP	0.02	0.00	0.00	0.00	0.00
Total: All Processes	0.01	0.04	0.06	0.12	0.00
Storage Tanks: Condensate	0.01	12.14	0.05	0.00	0.00
Natural Gas Fired Two-Cycle Lean-Burn Compressor Engines less than 50 HP	0.01	0.00	0.01	0.00	0.00
Natural Gas Fired Two-Cycle Lean-Burn Compressor Engines from 50 to 499 HP	0.00	0.01	0.01	0.00	0.00
Oil Well Completion: All Processes	0.00	2.36	0.02	0.00	0.00
Natural Gas Fired Four-Cycle Rich-Burn Compressor Engines Above 500 HP with NSCR	0.00	0.00	0.01	0.00	0.00
Storage Tanks: Crude Oil	0.00	18.90	0.02	0.00	0.00
Gas Well Dehydrators	0.00	0.03	0.00	0.00	0.00
Tank Truck/Railcar Loading: Crude Oil	0.00	1.18	0.00	0.00	0.00
Tank Truck/Railcar Loading: Condensate	0.00	0.18	0.00	0.00	0.00
Total: All Processes	0.00	0.00	0.00	0.00	0.00
Produced Water	0.00	3.78	0.00	0.00	0.00
Oil Well Pneumatic Devices	0.00	3.39	0.00	0.00	0.00
Fugitives: Other	0.00	1.00	0.00	0.00	0.00
Gas Well Pneumatic Devices	0.00	0.82	0.00	0.00	0.00
Mud Degassing	0.00	0.82	0.00	0.00	0.00
Fugitives: Valves	0.00	0.68	0.00	0.00	0.00
Gas Well Pneumatic Pumps	0.00	0.54	0.00	0.00	0.00
Fugitives: Other	0.00	0.38	0.00	0.00	0.00
Oil Well Pneumatic Pumps	0.00	0.38	0.00	0.00	0.00
Fugitives: Pumps	0.00	0.26	0.00	0.00	0.00
Gas Well Venting	0.00	0.23	0.00	0.00	0.00
Fugitives: Connectors	0.00	0.19	0.00	0.00	0.00
Mud Degassing	0.00	0.09	0.00	0.00	0.00
Fugitives: Valves	0.00	0.08	0.00	0.00	0.00

<b>Oil and Gas Production Equipment</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Fugitives: Open Ended Lines	0.00	0.07	0.00	0.00	0.00
Fugitives: Connectors	0.00	0.07	0.00	0.00	0.00
Fugitives: Pumps	0.00	0.05	0.00	0.00	0.00
Fugitives: Flanges	0.00	0.04	0.00	0.00	0.00
Gas Well Completion: All Processes	0.00	0.04	0.00	0.00	0.00
Fugitives: Open Ended Lines	0.00	0.03	0.00	0.00	0.00
Fugitives: Flanges	0.00	0.03	0.00	0.00	0.00
<b>Oil and Gas Production Total</b>	<b>1.96</b>	<b>47.92</b>	<b>2.85</b>	<b>0.13</b>	<b>0.10</b>

Daily average drilling rig emission estimates for 2012 and 2017 are summarized in Table 4-3: *2012 and 2017 HGB Area Drilling Rig Emission Estimates*. The 2012 estimates were based on the ERG study, [2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventories](#), which is available on the [TCEQ Air Quality Research and Contracts Reports: Emissions Inventory web page](#).

**Table 4-3: 2012 and 2017 HGB Area Drilling Rig Emission Estimates**

<b>Calendar Year for Drilling Rig Activity</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
2012 Drilling Rig Emissions	0.81	0.06	0.26	0.00	0.04
2017 Drilling Rig Emissions	0.57	0.07	0.25	0.00	0.03

The 2017 drilling rig emission estimates were obtained by applying 2017 emission factors to the 2015 drilling activity summarized in Table 4-4: *2015 HGB Area Oil and Gas Drilling Activity*. Different emission rates apply based on average well depth and whether conventional “vertical only” drilling is being done versus horizontal drilling commonly associated with fracturing. Since drilling rig equipment is subject to federal non-road emission standards, average emission rates decline over time due to fleet turnover. Drilling rig emission rates for each year from 2012-2040 are summarized in Chapter 6: Emissions Factor Development of the [2014 Statewide Drilling Rig Emissions Inventory with Updated Trends Inventory](#) ERG study.

**Table 4-4: 2015 HGB Area Oil and Gas Drilling Activity**

<b>Type and Depth of 2015 Drilling Levels</b>	<b>2015 Thousands of Feet Drilled</b>
Vertical/Horizontal Drilling	335
Vertical Drilling less than 7,000 Feet	514
Vertical Drilling greater than 7,000 Feet	232

The production and drilling rig emission estimates presented above were prepared for photochemical model input using EPS3. Spatial allocation of these emission estimates was based on the latest available activity data from the RRC. For example, 2014 natural gas production data for each operational well were used to develop a weighted surrogate for allocating 2017 natural gas production emissions. A similar approach was used to develop separate weighted surrogates for emissions associated with crude

oil and condensate production. 2017 drilling rig emissions were allocated to locations where 2015 wells were drilled. Even though it is unlikely that 2017 drilling will occur in the exact same locations as 2015, low-level emissions are evenly distributed within 4 kilometer (km) grid cells for photochemical model input. Since 2017 production and drilling is likely to be concentrated near currently operational wells, this spatial allocation approach is reasonable. 2012 production and drilling rig emissions were allocated based on available RRC data specific to that year.

For the non-HGB areas of Texas, the steps described above are similar for the development and EPS3 processing of emissions associated with drilling rigs and production of natural gas, crude oil, and condensate. For projecting to 2017, the latest available RRC activity data from 2014 were obtained for every Texas county. The ERG [\*Growth Factors for Area and Point Sources\*](#) study provided different emission projection factors for the Barnett, Eagle Ford, Haynesville, and Permian Basin formations. The EPS3 processing streams for emissions from oil and gas activities are divided into seven separate streams for:

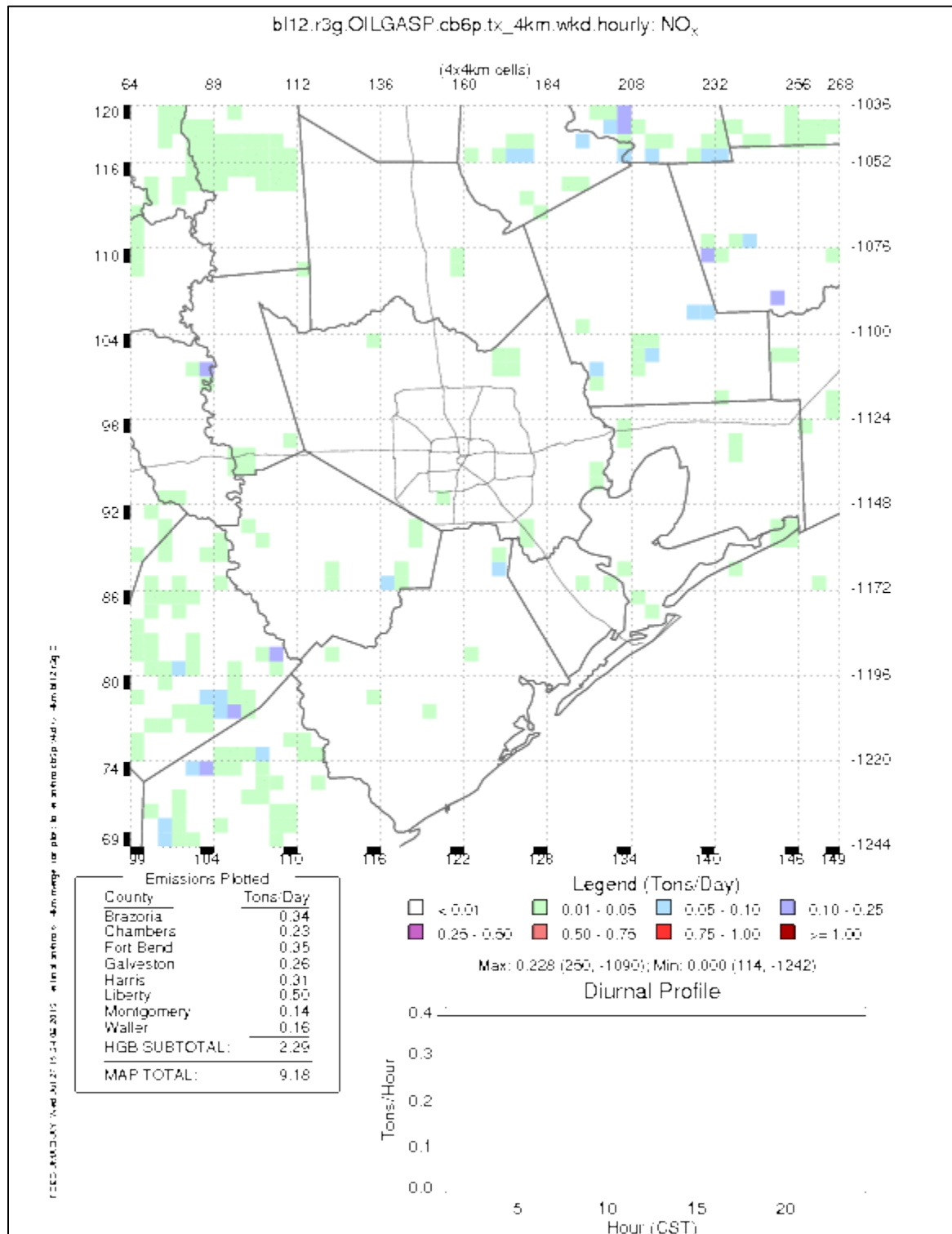
- the eight-county HGB area;
- the 10-county DFW area;
- the eight Barnett Shale counties of Cooke, Erath, Hill, Hood, Jack, Montague, Palo Pinto, and Somervell not included within the 10-county DFW area;
- the 10 counties comprising the Texas portion of the Haynesville Shale;
- the 26 counties within the Eagle Ford Shale in South Texas;
- the 45 counties within the Permian Basin in West Texas; and
- the remaining 147 Texas counties.

The complete EPS3 processing streams for the oil and gas activities are available for both [2012](#) and [2017](#) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/oil\\_gas/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/oil_gas/tex/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/oil\\_gas/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/oil_gas/tex/), respectively.

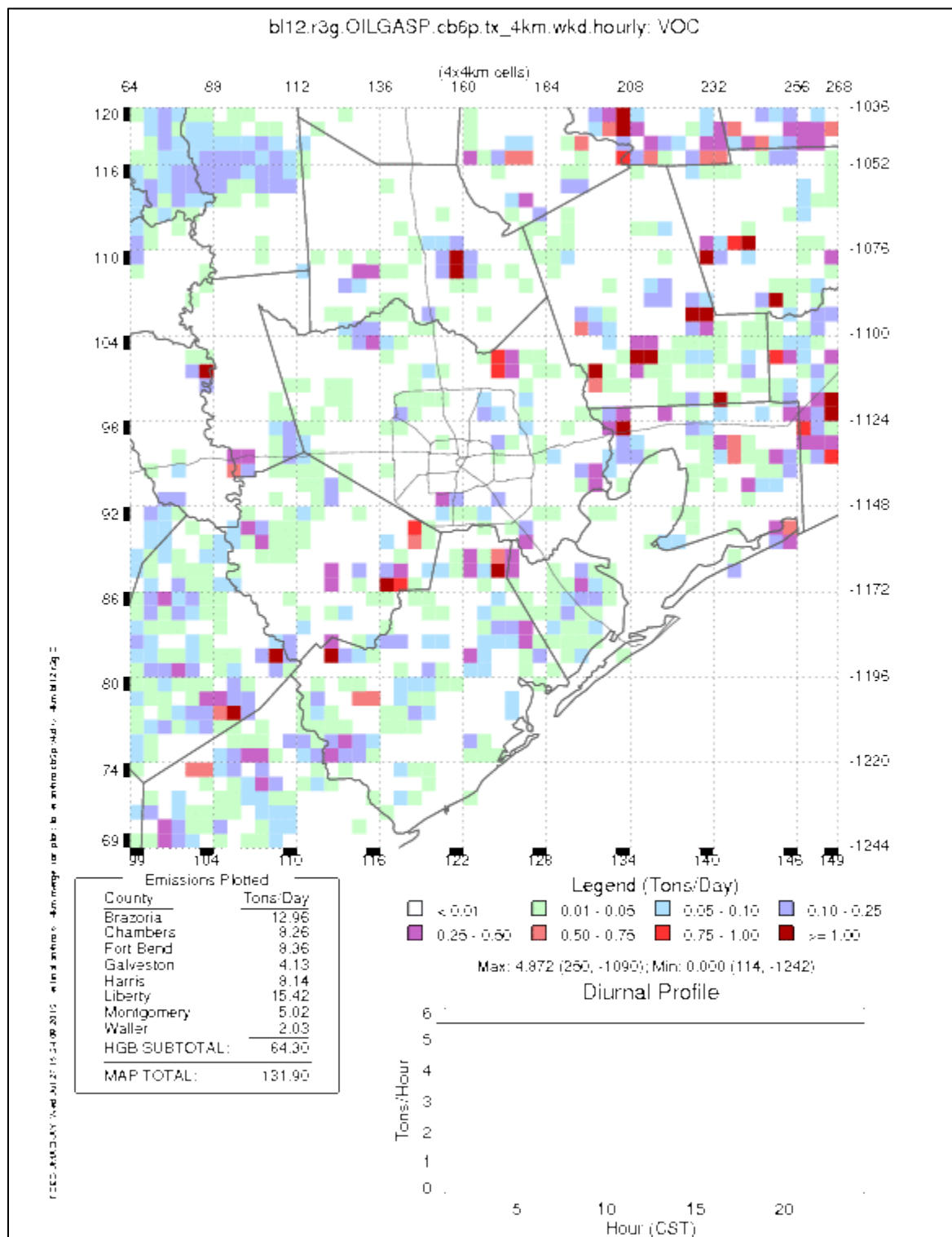
The following pages contain graphical plots of the 2012 and 2017 oil and gas production and drilling NO<sub>x</sub> and VOC emissions for the HGB area. These plots are titled Figure 4-1: *2012 HGB Oil and Gas Production NO<sub>x</sub> Emissions Distribution*, Figure 4-2: *2012 HGB Oil and Gas Production VOC Emissions Distribution*, Figure 4-3: *2017 HGB Oil and Gas Production NO<sub>x</sub> Emissions Distribution*, and Figure 4-4: *2017 HGB Oil and Gas Production VOC Emissions Distribution*. Spatial allocation of drilling rig emission estimates for 2012 and 2017, respectively, are provided in Figure 4-5: *2012 HGB Drilling Rig NO<sub>x</sub> Emissions Distribution* and Figure 4-6: *2017 HGB Drilling Rig NO<sub>x</sub> Emissions Distribution*. Since diesel-powered drilling rig equipment emits low levels of VOC, only NO<sub>x</sub> plots are provided.

For the non-Texas U.S. areas of the modeling domain, oil and gas emission estimates from the EPA NEI were used. The [2011 oil and gas NEI](#) was projected to 2012 and 2017 to develop the non-Texas inputs based on growth factors from the U.S. Energy Information Administration (EIA). The oil and gas emission estimates from the NEI datasets were processed through EPS3 in a manner similar to that described above for the oil and gas emissions within Texas. The non-Texas EPS3 processing streams for oil

and gas emissions for 2012 and 2017 are available at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/oil\\_gas/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/oil_gas/usa/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/oil\\_gas/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/oil_gas/usa/), respectively.



**Figure 4-1: 2012 HGB Oil and Gas Production NO<sub>x</sub> Emissions Distribution**



**Figure 4-2: 2012 HGB Oil and Gas Production VOC Emissions Distribution**

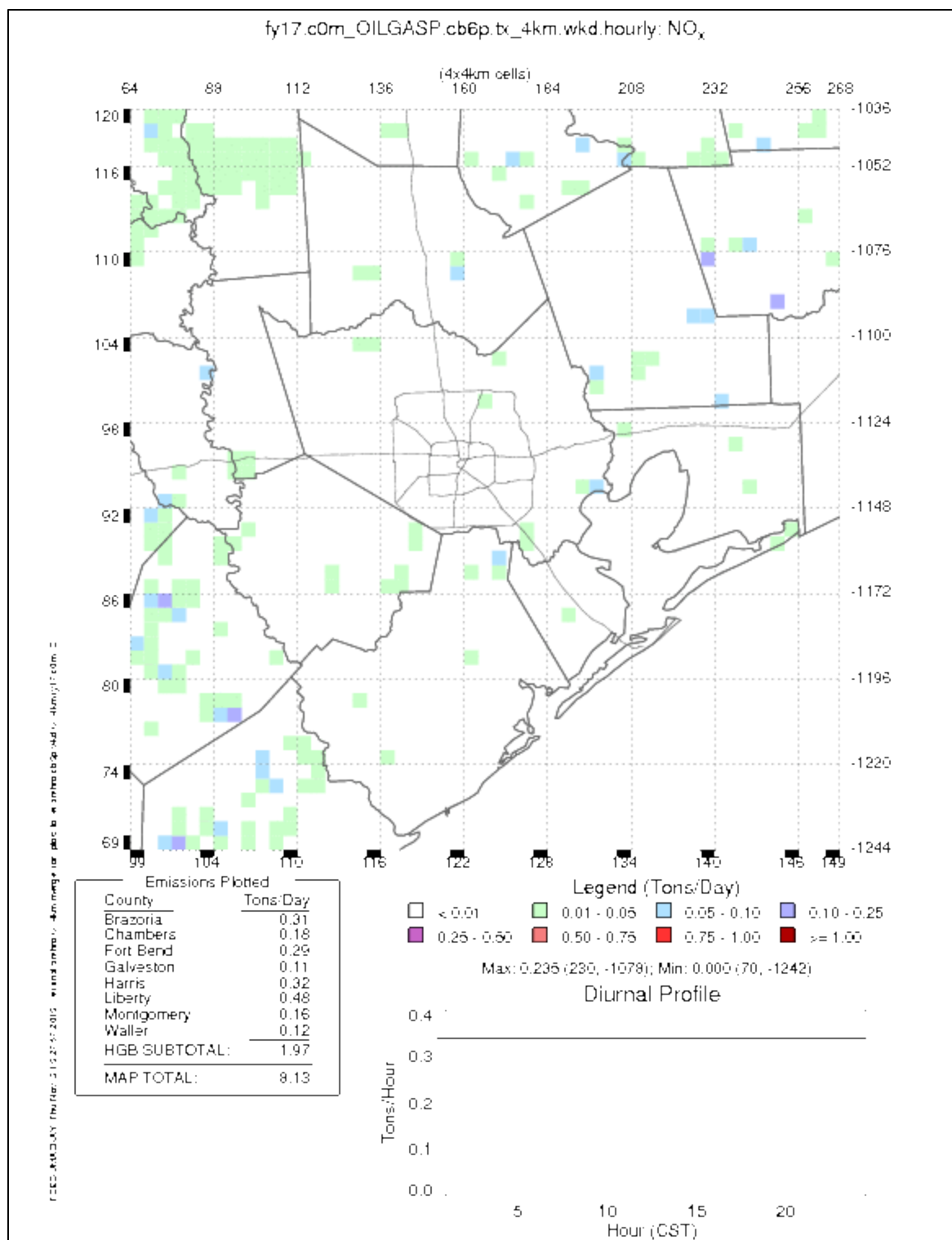


Figure 4-3: 2017 HGB Oil and Gas Production NO<sub>x</sub> Emissions Distribution

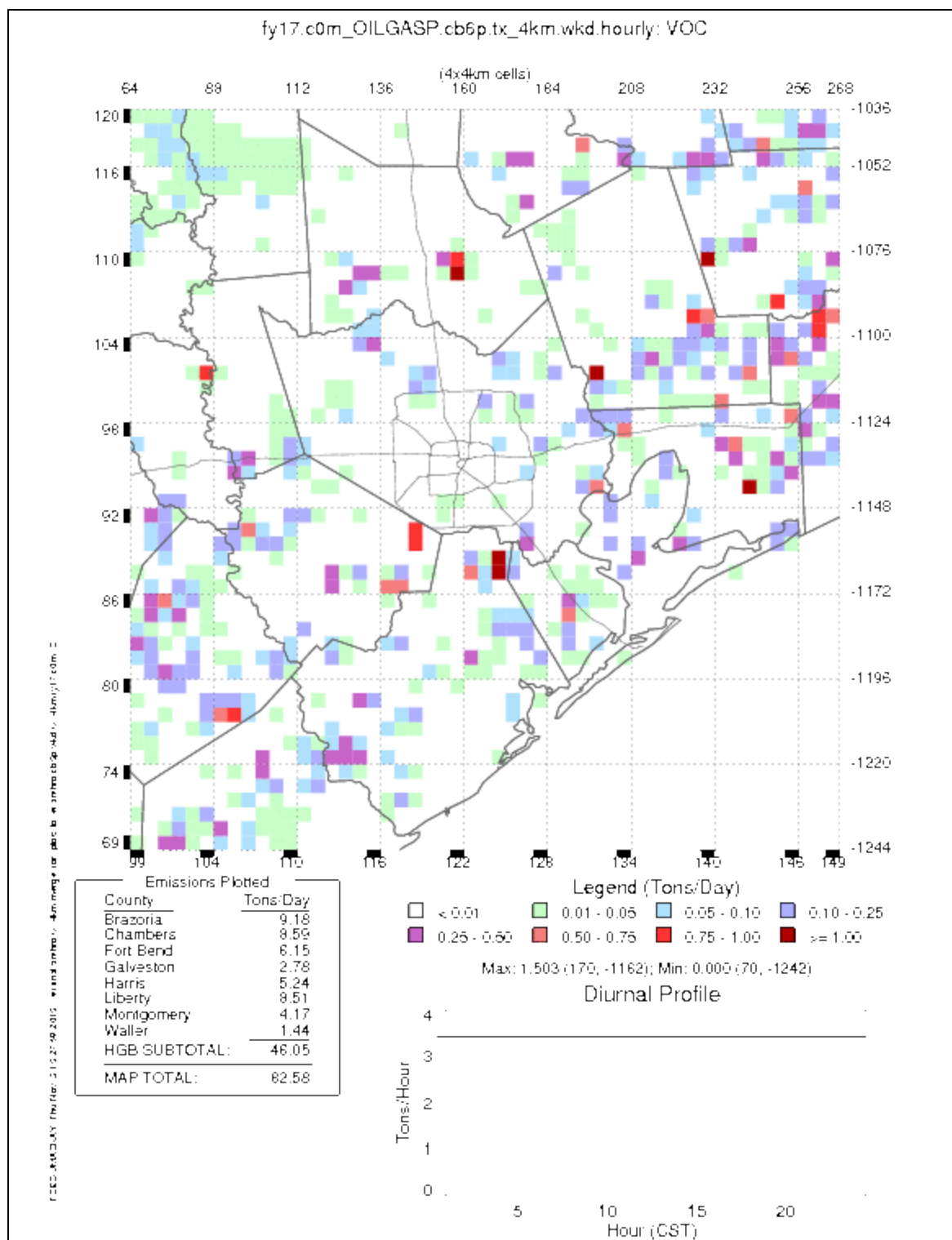


Figure 4-4: 2017 HGB Oil and Gas Production VOC Emissions Distribution



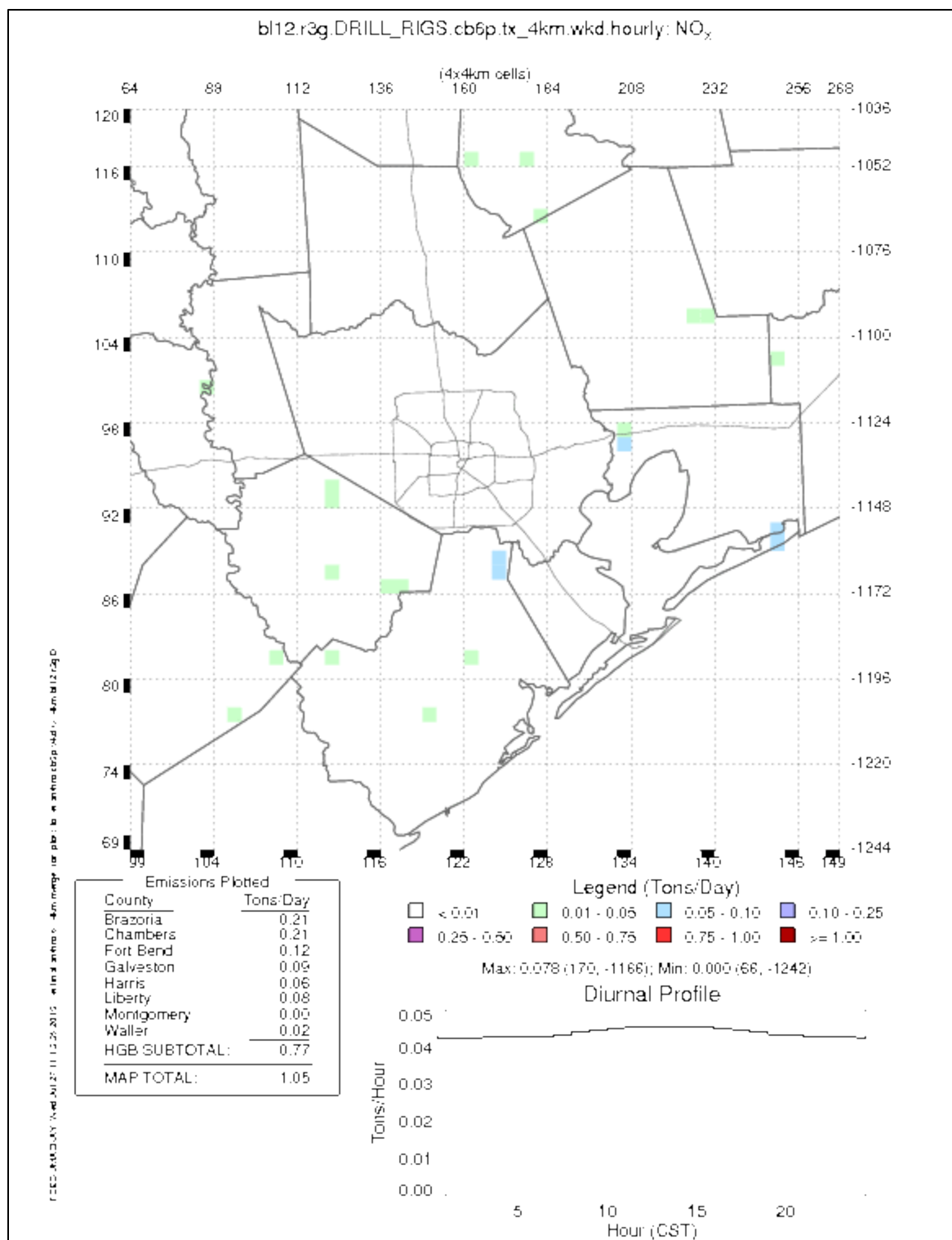


Figure 4-5: 2012 HGB Drilling Rig NO<sub>x</sub> Emissions Distribution

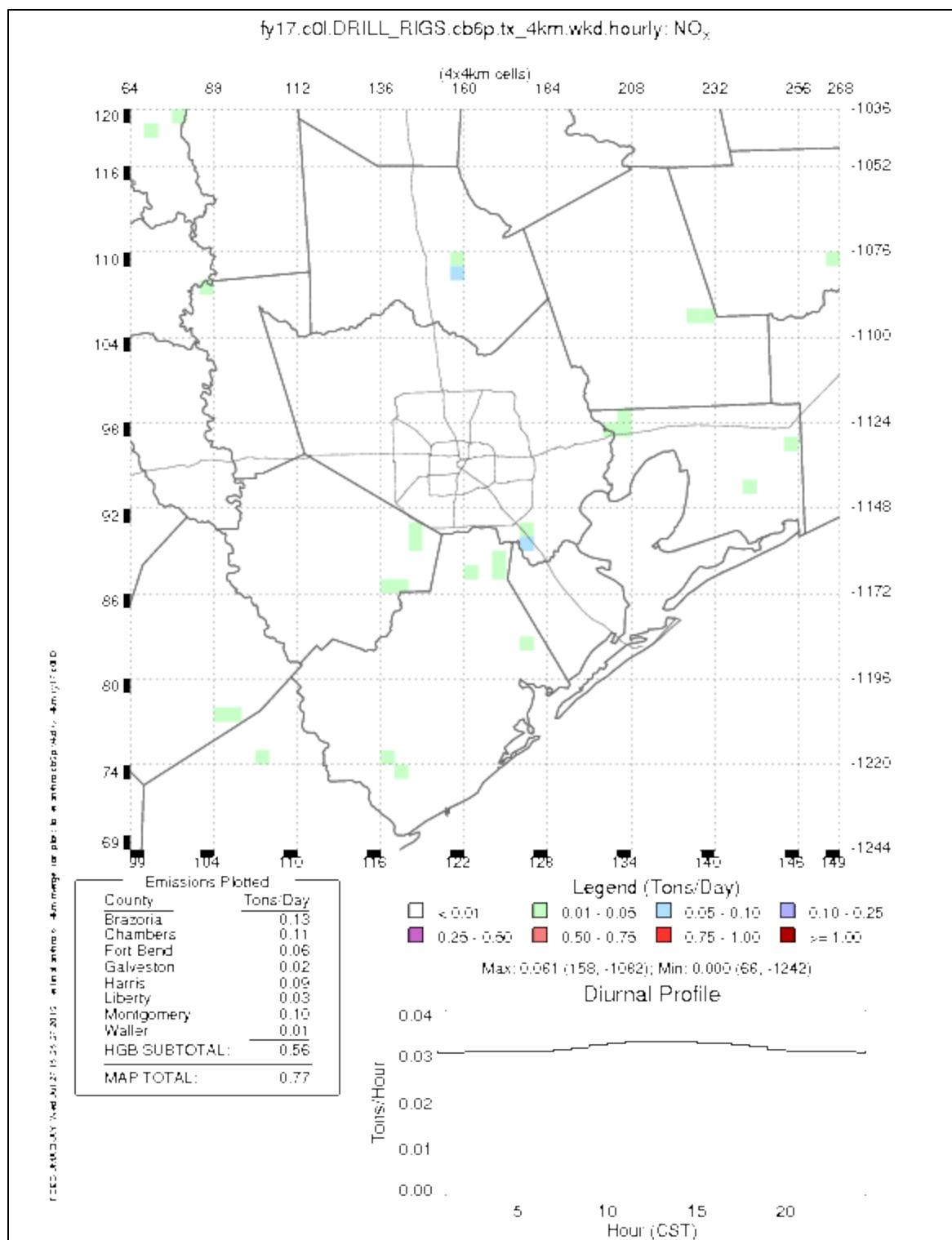


Figure 4-6: 2017 HGB Drilling Rig NO<sub>x</sub> Emissions Distribution

## 4.2 AIRPORTS

Airport emission estimates for 2012 and 2017 were based on a July 2015 ERG study, [Aircraft Emissions Inventory for Texas Statewide 2014 AERR Inventory and 2008 to 2014 Trend Analysis Years](#). At the time that the ERG work was performed, the latest version of the [Emissions and Dispersion Modeling System \(EDMS\)](#) from the Federal Aviation Administration (FAA) was used. For past years, historical flight activity for each airport is input to the EDMS model. Future year flight activity are based on [Terminal Area Forecast \(TAF\)](#) datasets available from FAA. In addition to estimating emissions from aircraft activity, the EDMS model outputs estimates for auxiliary power units (APUs) and ground support equipment (GSE) at major airports. 2012 summaries of aircraft, APU, and GSE emission estimates for George Bush Intercontinental, Houston Hobby, and the smaller regional airports throughout HGB are presented in Table 4-5: *2012 George Bush Intercontinental Airport Emissions by Source Type*, Table 4-6: *2012 Houston Hobby Airport Emissions by Source Type*, and Table 4-7: *2012 HGB Area Regional Airport Emissions by Source Type*, respectively. The EDMS model estimates emissions associated with parking garage activity and routine construction at major airports, but these are already included in the comprehensive TCEQ on-road and non-road construction emission inventories. 2012 emission totals for George Bush Intercontinental, Houston Hobby, and the smaller regional airports are presented in Table 4-8: *2012 HGB Area Major and Regional Airport Emissions*.

**Table 4-5: 2012 George Bush Intercontinental Airport Emissions by Source Type**

<b>George Bush Intercontinental Airport Source Category</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Aircraft Operation	4.36	1.17	7.01	0.58	0.08
Auxiliary Power Units	0.13	0.01	0.17	0.02	0.02
Ground Support Equipment	0.19	0.06	1.40	0.00	0.01
George Bush Intercontinental Airport Total	4.69	1.24	8.58	0.61	0.11

**Table 4-6: 2012 Houston Hobby Airport Emissions by Source Type**

<b>Houston Hobby Airport Source Category</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Aircraft Operation	1.39	0.39	1.85	0.16	0.02
Auxiliary Power Units	0.03	0.00	0.06	0.00	0.01
Ground Support Equipment	0.06	0.02	0.54	0.00	0.00
Houston Hobby Airport Total	1.48	0.41	2.44	0.17	0.03

**Table 4-7: 2012 HGB Area Regional Airport Emissions by Source Type**

<b>Regional Airports Source Category</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Aircraft Operation	0.22	0.46	8.70	0.05	0.14
Auxiliary Power Units	0.00	0.00	0.01	0.00	0.00
Ground Support Equipment	0.05	0.01	0.22	0.00	0.00
Regional Airports Total	0.27	0.47	8.93	0.05	0.14

**Table 4-8: 2012 HGB Area Major and Regional Airport Emissions**

HGB Area Airport or Airport Group	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
George Bush Intercontinental	4.69	1.24	8.58	0.61	0.11
Houston Hobby	1.48	0.41	2.44	0.17	0.03
Regional Airports	0.27	0.47	8.93	0.05	0.14
HGB Area Airport Total	6.44	2.11	19.95	0.82	0.28

2017 summaries of aircraft, APU, and GSE emission estimates for HGB are shown in Table 4-9: *2017 George Bush Intercontinental Airport Emissions by Source Type*, Table 4-10: *2017 Houston Hobby Airport Emissions by Source Type*, and Table 4-11: *2017 HGB Area Regional Airport Emissions by Source Type*, respectively. 2017 emission totals for George Bush Intercontinental, Houston Hobby, and the smaller regional airports are presented in Table 4-12: *2017 HGB Area Major and Regional Airport Emissions*.

**Table 4-9: 2017 George Bush Intercontinental Airport Emissions by Source Type**

George Bush Intercontinental Airport Source Category	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Aircraft Operation	4.59	1.23	7.38	0.61	0.08
Auxiliary Power Units	0.14	0.02	0.18	0.02	0.02
Ground Support Equipment	0.20	0.06	1.47	0.01	0.01
George Bush Intercontinental Airport Total	4.93	1.30	9.04	0.64	0.12

**Table 4-10: 2017 Houston Hobby Airport Emissions by Source Type**

Houston Hobby Airport Source Category	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Aircraft Operation	1.54	0.43	2.04	0.18	0.03
Auxiliary Power Units	0.03	0.00	0.06	0.01	0.01
Ground Support Equipment	0.06	0.02	0.60	0.00	0.00
Houston Hobby Airport Total	1.63	0.45	2.70	0.19	0.03

**Table 4-11: 2017 HGB Area Regional Airport Emissions by Source Type**

Regional Airports Source Category	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Aircraft Operation	0.23	0.48	9.35	0.05	0.15
Auxiliary Power Units	0.00	0.00	0.01	0.00	0.00
Ground Support Equipment	0.05	0.01	0.22	0.00	0.00
Regional Airports Total	0.28	0.49	9.58	0.05	0.15

**Table 4-12: 2017 HGB Area Major and Regional Airport Emissions**

HGB Area Airport or Airport Group	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
George Bush Intercontinental	4.93	1.30	9.04	0.64	0.12
Houston Hobby	1.63	0.45	2.70	0.19	0.03

HGB Area Airport or Airport Group	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Regional Airports	0.28	0.49	9.58	0.05	0.15
HGB Area Airport Total	6.85	2.24	21.32	0.88	0.30

The airport emissions were prepared for photochemical modeling input using EPS3. The emissions were allocated to grid cells using spatial surrogates based on the respective areal extent of each airport. The EPS3 processing for Texas airport emissions was separated into streams for:

- the eight-county HGB area;
- the 10-county DFW area; and
- the remaining 236 Texas counties.

The complete EPS3 processing streams for the airports are available for [2012](#) and [2017](#) at

[ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/offroad/airport/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/offroad/airport/tex/) and

[ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/offroad/airport/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/offroad/airport/tex/), respectively. The following pages contain graphical plots of the 2012 and 2017 airport NO<sub>x</sub> emissions for the HGB area. These plots are respectively titled Figure 4-7: *2012 HGB Airport NO<sub>x</sub> Emissions Distribution* and Figure 4-8: *2017 HGB Airport NO<sub>x</sub> Emissions Distribution*. Since airports are not significant contributors of VOC emissions, only NO<sub>x</sub> plots are provided.

For the non-Texas U.S. areas of the modeling domain, airport emission estimates from the [EPA 2011 NEI](#) were projected to 2012 and 2017. The airport emission estimates from the NEI datasets were processed through EPS3 in a manner similar to that described above for the airport emissions within Texas. The EPS3 airport processing streams for the non-Texas areas for [2012](#) and [2017](#) are available at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/offroad/airport/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/offroad/airport/usa/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/offroad/airport/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/offroad/airport/usa/), respectively.

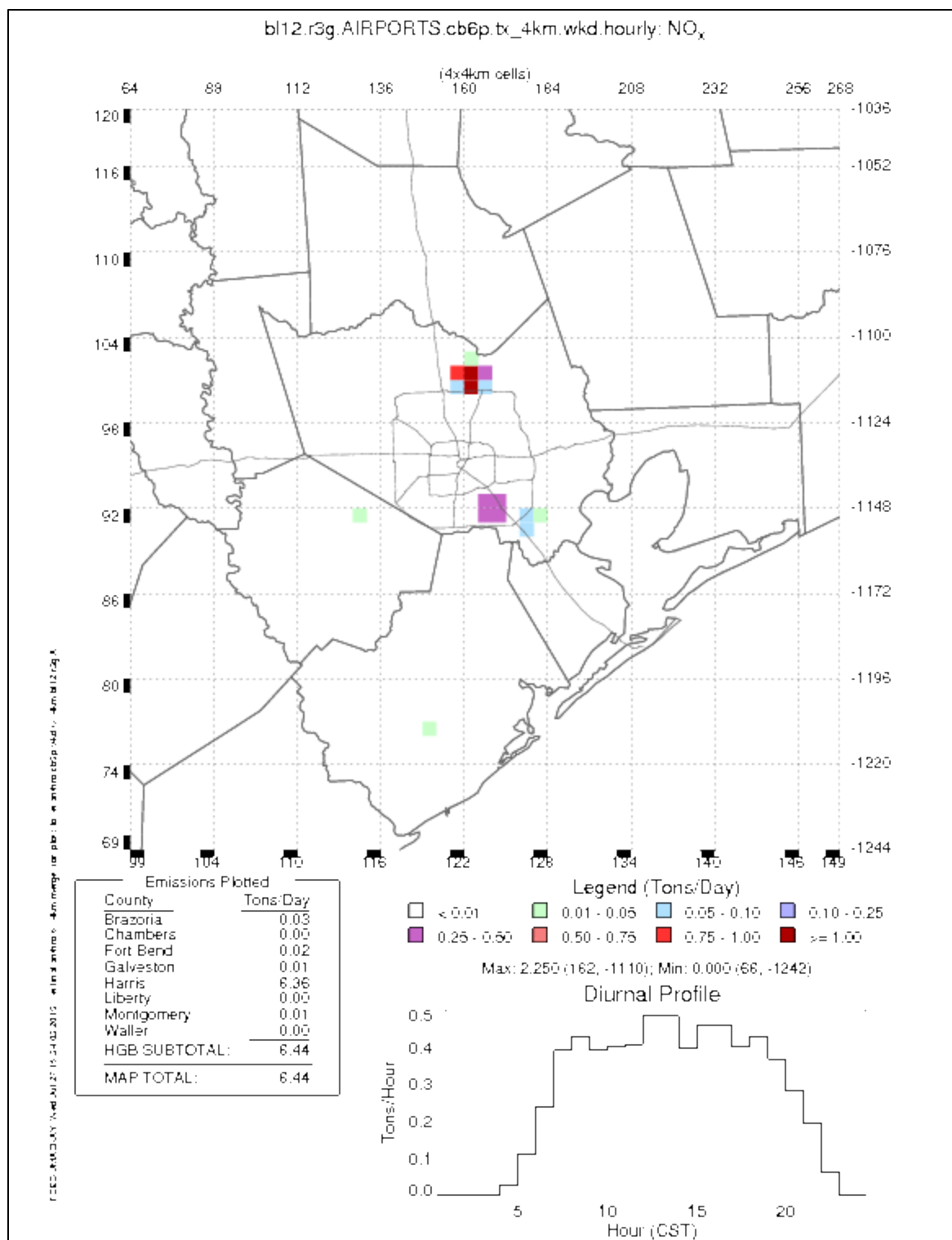


Figure 4-7: 2012 HGB Airport NO<sub>x</sub> Emissions Distribution

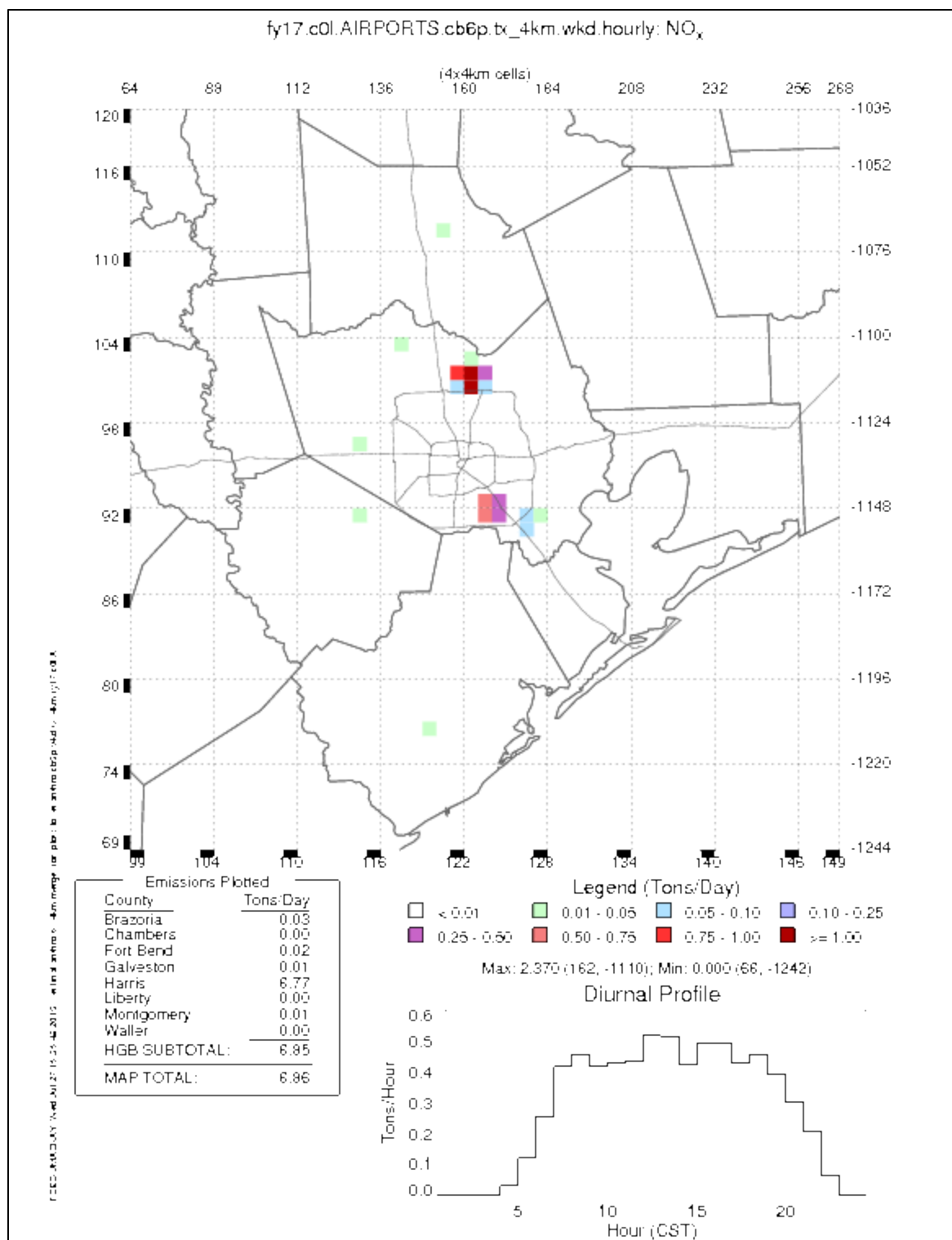


Figure 4-8: 2017 HGB Airport NO<sub>x</sub> Emissions Distribution

### 4.3 LOCOMOTIVES

Locomotive emission estimates for 2012 and 2017 were based on an August 2015 ERG study, [2014 Texas Statewide Locomotive Emissions Inventory and 2008 through 2040 Trend Inventories](#). The locomotive emissions data output from TexAER were prepared for photochemical modeling using EPS3. Table 4-13: *EPS3 Modules for Processing Locomotive Emissions* summarizes the steps that were taken to process the 2012 and 2017 locomotive inventories.

**Table 4-13: EPS3 Modules for Processing Locomotive Emissions**

EPS3 Module	Description
LBASE	Assign line-haul emissions to known railway segments (not for switchers).
PREAM	Convert text-based input files to binary format for further processing.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
TMPRL	Apply profiles to temporally allocate daily emission totals.
CNTLEM	Apply temperature/humidity NO <sub>x</sub> correction.
GRDEM	Spatially allocate switcher emissions with surrogates.

The 24-hour locomotive emission totals estimated in the trends study do not account for the effects of hourly variation in temperature and humidity on NO<sub>x</sub> emissions. Greater detail on the development of correction equations to account for these effects can be found in Appendices [F.4: Humidity and Temperature Correction Factors for NO<sub>x</sub> Emissions from Diesel Engines](#) and [F.5: Humidity and Temperature Correction Factors for NO<sub>x</sub> Emissions from Spark Ignited Engines](#) of the [December 2004 HGB SIP revision](#). During EPS3 processing, the CNTLEM module is also used to apply an hourly temperature/humidity NO<sub>x</sub> correction and the impacts on the 2012 and 2017 locomotive HGB inventories are presented in Table 4-14: *Temperature/Humidity NO<sub>x</sub> Correction for Locomotive Emissions*.

**Table 4-14: Temperature/Humidity NO<sub>x</sub> Correction for Locomotive Emissions**

Locomotive Source Classification Description	2012 NO <sub>x</sub> Change (tpd)	2017 NO <sub>x</sub> Change (tpd)
Line-Haul Locomotives – Class I	-1.49	-1.22
Line-Haul Locomotives – Classes II and III	-0.04	-0.04
Rail-Yard Switcher Locomotives	-0.38	-0.36
HGB Area Total	-1.90	-1.62

Locomotive activity levels do not vary much by day type, so there are negligible differences in weekday versus weekend emissions for this source category. The line-haul emissions were spatially allocated to individual railway segments based on gross ton miles (GTM) activity data. The switcher emissions were allocated to known rail yards within the HGB area. Table 4-15: *2012 HGB Locomotive Emissions* and Table 4-16: *2017 HGB Locomotive Emissions* present the 2012 and 2017 HGB area locomotive emission inputs for the photochemical model for each episode day in these respective years.



**Table 4-15: 2012 HGB Locomotive Emissions**

<b>Locomotive Source Classification Description</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>NH<sub>3</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Line-Haul Locomotives – Class I	11.97	0.74	2.65	0.01	0.01	0.40
Line-Haul Locomotives – Classes II and III	0.29	0.02	0.03	0.00	0.00	0.01
Rail-Yard Switcher Locomotives	3.09	0.23	0.45	0.00	0.00	0.08
HGB Area Total	15.34	0.99	3.14	0.01	0.01	0.48

**Table 4-16: 2017 HGB Locomotive Emissions**

<b>Locomotive Source Classification Description</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>NH<sub>3</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Line-Haul Locomotives – Class I	9.79	0.50	2.74	0.01	0.01	0.29
Line-Haul Locomotives – Classes II and III	0.30	0.02	0.04	0.00	0.00	0.01
Rail-Yard Switcher Locomotives	2.99	0.22	0.48	0.00	0.00	0.08
HGB Area Total	13.08	0.73	3.26	0.01	0.01	0.37

For the non-HGB areas of Texas, the steps described above are similar for the development and EPS3 processing of locomotive emission estimates for 2012 and 2017. The EPS3 processing for Texas locomotive emissions is divided into streams for:

- the eight-county HGB area;
- the 10-county DFW area; and
- the remaining 236 Texas counties.

The EPS3 processing streams for locomotives are available for both [2012](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/offroad/locomotive/tex/) and [2017](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/offroad/locomotive/tex/) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/offroad/locomotive/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/offroad/locomotive/tex/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/offroad/locomotive/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/offroad/locomotive/tex/), respectively. The following pages contain graphical plots of the 2012 and 2017 locomotive NO<sub>x</sub> emissions for the HGB area. These plots are respectively titled Figure 4-9: *2012 HGB Locomotive NO<sub>x</sub> Emissions Distribution* and Figure 4-10: *2017 HGB Locomotive NO<sub>x</sub> Emissions Distribution*. Since the diesel engines that power locomotives are not significant contributors of VOC emissions, only NO<sub>x</sub> plots are provided here.

For the non-Texas U.S. areas of the modeling domain, locomotive emission estimates from the [EPA 2011 NEI](#) were projected to 2012 and 2017. The locomotive emission estimates from the NEI datasets were processed through EPS3 in a manner similar to that described above for the locomotive emissions within Texas. The EPS3 locomotive processing streams for the non-Texas areas for [2012](#) and [2017](#) are available at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/offroad/locomotive/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/offroad/locomotive/usa/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/offroad/locomotive/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/offroad/locomotive/usa/), respectively.

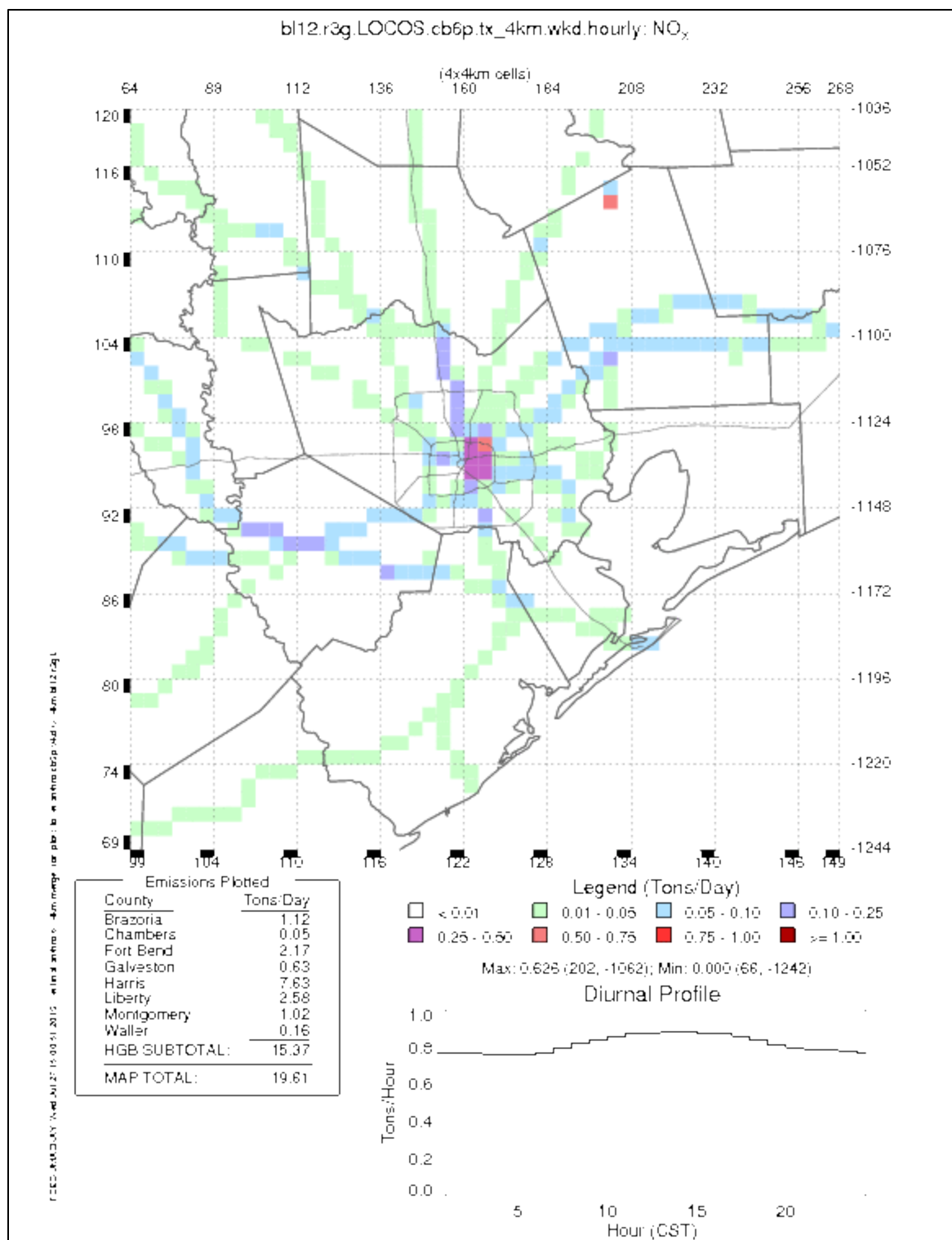


Figure 4-9: 2012 HGB Locomotive NO<sub>x</sub> Emissions Distribution

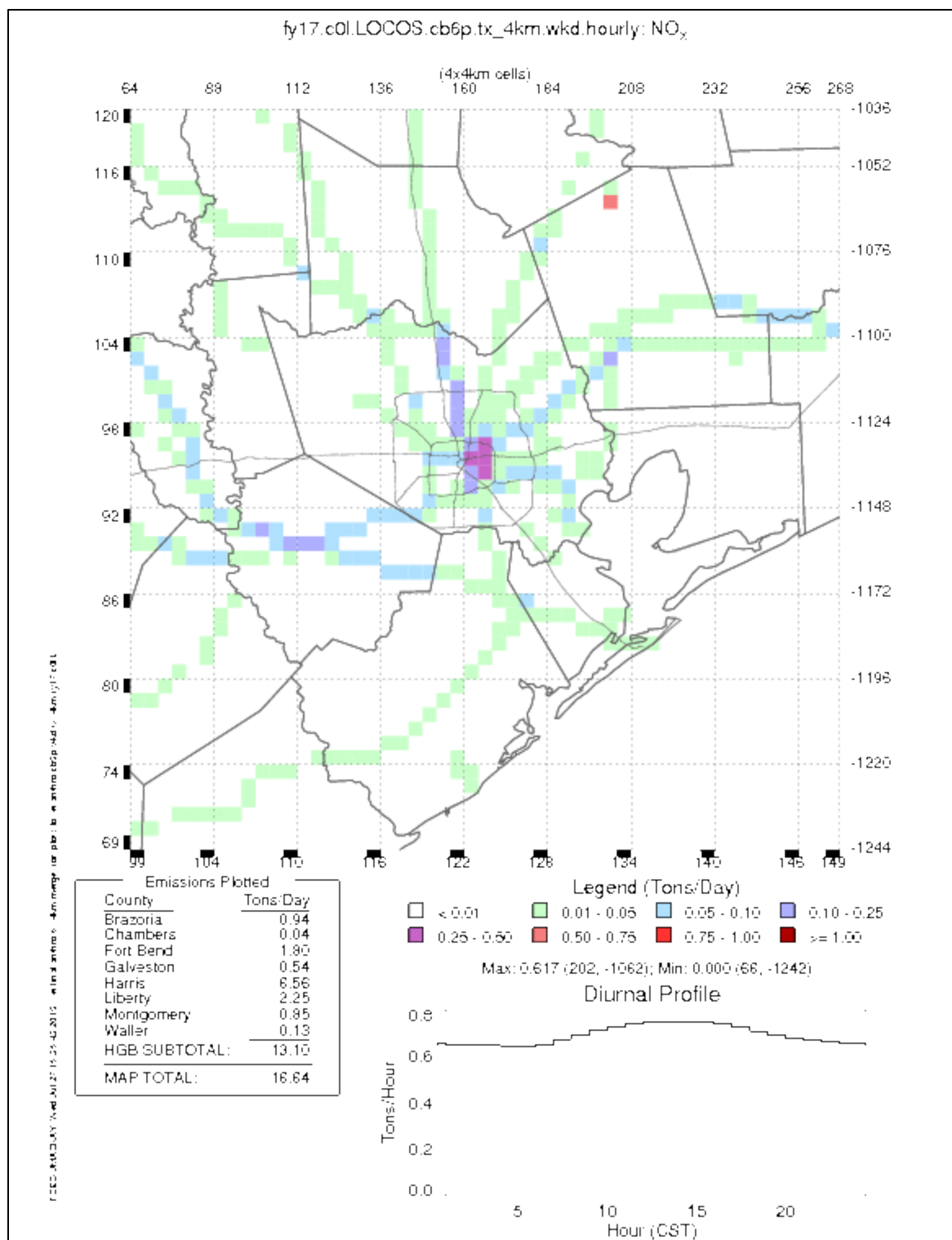


Figure 4-10: 2017 HGB Locomotive NO<sub>x</sub> Emissions Distribution

#### 4.4 NON-ROAD/TEXN

Non-road emissions for 2012 and 2017 for the eight-county HGB area were estimated with a customized version of [EPA's NONROAD model](#) called [Texas NONROAD \(TexN\)](#). For each county specified in a TexN scenario, 25 separate runs of the NONROAD model are performed for the non-road categories outlined in Table 4-17: *Texas NONROAD Model Subsector Categories*. Runs 1 through 25 (excluding 24) are for specific diesel construction equipment (DCE) categories, while the numeric code of '0' is for all non-DCE categories.

**Table 4-17: Texas NONROAD Model Subsector Categories**

<b>Numeric Code</b>	<b>NONROAD Model Subsector Description (Diesel Construction Equipment for 1-24)</b>
0	Other - Non-Diesel Construction Equipment
1	DCE - Agricultural Activities
2	DCE - Boring and Drilling Equipment
3	DCE - Brick and Stone Operations
4	DCE - City and County Road Construction
5	DCE - Commercial Construction
6	DCE - Concrete Operations
7	DCE - County-Owned Construction Equipment
8	DCE – Cranes
9	DCE - Heavy Highway Construction
10	DCE - Landfill Operations
11	DCE - Landscaping Activities
12	DCE - Manufacturing Operations
13	DCE - Municipal-Owned Construction Equipment
14	DCE - Transportation/Sales/Services
15	DCE - Residential Construction
16	DCE - Rough Terrain Forklifts
17	DCE - Scrap/Recycling Operations
18	DCE - Skid Steer Loaders
19	DCE - Special Trades Construction
20	DCE - Trenchers
21	DCE - TxDOT Construction Equipment
22	DCE - Utility Construction
23	DCE - Mining and Quarry Operation
25	DCE - Off-Road Tractors, Miscellaneous, and Equipment Under 25 Horsepower

2012 and 2017 summer weekday scenarios were run with the TexN model for the eight counties in the HGB area. 25 DCE subcategories for the eight counties resulted in 200 NONROAD model runs for each calendar year. The results of this work are available on the HGB non-road emissions FTP site for [2012](#) and [2017](#) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/nonroad/tex/texn/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/nonroad/tex/texn/) and

[ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/nonroad/tx/texn/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/nonroad/tx/texn/), respectively. The NO<sub>x</sub>, VOC, CO, SO<sub>2</sub>, and PM<sub>2.5</sub> emissions by county along with associated non-road equipment population figures are presented for 2012 and 2017, respectively, in Table 4-18: *2012 HGB Area Non-Road Emissions Inventory by County* and Table 4-19: *2017 HGB Area Non-Road Emissions Inventory by County*.

**Table 4-18: 2012 HGB Area Non-Road Emissions Inventory by County**

HGB Area County	Equipment Population	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Brazoria	111,661	3.57	2.68	24.31	0.01	0.31
Chambers	23,724	0.83	0.87	4.99	0.00	0.07
Fort Bend	128,539	4.32	2.13	31.57	0.01	0.39
Galveston	146,352	2.44	2.99	22.62	0.01	0.22
Harris	1,441,923	39.84	26.85	391.72	0.12	3.20
Liberty	28,141	1.27	0.51	5.30	0.00	0.11
Montgomery	155,189	3.38	3.72	33.94	0.01	0.35
Waller	15,783	0.94	0.38	3.98	0.00	0.09
HGB Total	2,051,311	56.58	40.13	518.44	0.17	4.74

**Table 4-19: 2017 HGB Area Non-Road Emissions Inventory by County**

HGB Area County	Equipment Population	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Brazoria	121,443	2.46	1.93	21.74	0.01	0.22
Chambers	25,317	0.50	0.59	4.14	0.00	0.04
Fort Bend	142,867	3.30	1.71	29.67	0.01	0.31
Galveston	157,924	1.65	2.18	21.14	0.00	0.16
Harris	1,582,771	27.63	19.66	358.38	0.08	2.52
Liberty	30,885	0.78	0.40	4.71	0.00	0.07
Montgomery	167,931	2.31	2.83	32.30	0.01	0.26
Waller	17,285	0.59	0.30	3.69	0.00	0.05
HGB Total	2,246,423	39.23	29.59	475.77	0.10	3.64

Even with overall growth in the non-road equipment population from roughly 2.1 million in 2012 to 2.2 million in 2017, total emissions decrease due to the more stringent emissions standards for new equipment purchases, combined with the simultaneous attrition of older, higher-emitting pieces of non-road equipment. The eight-county HGB non-road emissions inventory includes 195 different types of equipment referenced by source classification code (SCC). The eight-county HGB aggregate equipment categories for 2012 and 2017, respectively, are summarized in Table 4-20: *2012 HGB Area Non-Road Emissions Inventory by Equipment Group* and Table 4-21: *2017 HGB Area Non-Road Emissions Inventory by Equipment Group*.

**Table 4-20: 2012 HGB Area Non-Road Emissions Inventory by Equipment Group**

<b>Equipment Category</b>	<b>Equipment Population</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Agricultural Equipment	7,148	4.59	0.43	4.04	0.01	0.37
Commercial Equipment	222,561	6.83	8.74	216.38	0.02	0.61
Construction and Mining Equipment	80,948	26.85	4.55	47.68	0.08	2.46
Industrial Equipment	35,048	16.00	3.79	74.75	0.04	0.49
Lawn and Garden Equipment	1,506,654	1.32	10.41	130.46	0.01	0.56
Logging Equipment	1,870	0.15	0.12	1.25	0.00	0.02
Pleasure Craft	124,084	0.66	7.58	23.09	0.00	0.08
Railroad Equipment	109	0.07	0.01	0.05	0.00	0.01
Recreational Equipment	72,888	0.13	4.51	20.74	0.00	0.12
<b>HGB Total</b>	<b>2,051,311</b>	<b>56.58</b>	<b>40.13</b>	<b>518.44</b>	<b>0.17</b>	<b>4.74</b>

**Table 4-21: 2017 HGB Area Non-Road Emissions Inventory by Equipment Group**

<b>Equipment Category</b>	<b>Equipment Population</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Agricultural Equipment	7,823	2.71	0.32	2.62	0.00	0.19
Commercial Equipment	250,623	5.58	6.75	223.16	0.02	0.52
Construction and Mining Equipment	101,651	20.68	4.10	42.57	0.03	1.87
Industrial Equipment	38,463	8.33	1.60	37.37	0.04	0.31
Lawn and Garden Equipment	1,637,943	1.04	8.29	127.05	0.01	0.60
Logging Equipment	2,107	0.06	0.13	1.26	0.00	0.02
Pleasure Craft	128,585	0.65	4.99	20.50	0.00	0.05
Railroad Equipment	123	0.05	0.01	0.04	0.00	0.01
Recreational Equipment	79,105	0.13	3.41	21.19	0.00	0.09
<b>HGB Total</b>	<b>2,246,423</b>	<b>39.23</b>	<b>29.59</b>	<b>475.77</b>	<b>0.10</b>	<b>3.64</b>

The eight-county HGB non-road emissions are summarized by fuel type for 2012 and 2017, respectively, in Table 4-22: *2012 HGB Area Non-Road Emissions Inventory by Fuel Type* and Table 4-23: *2017 HGB Area Non-Road Emissions Inventory by Fuel Type*.

**Table 4-22: 2012 HGB Area Non-Road Emissions Inventory by Fuel Type**

<b>Equipment Category</b>	<b>Equipment Population</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Two-Stroke Gasoline	669,181	0.38	15.94	45.96	0.00	0.91
Four-Stroke Gasoline	1,246,452	2.76	16.54	377.35	0.02	0.18
Diesel	103,978	40.63	4.05	22.39	0.11	3.49
Compressed Natural Gas (CNG)	1,681	0.40	0.21	2.26	0.00	0.01
Liquefied Petroleum Gas (LPG)	30,019	12.41	3.39	70.48	0.03	0.15
<b>HGB Total</b>	<b>2,051,311</b>	<b>56.58</b>	<b>40.13</b>	<b>518.44</b>	<b>0.17</b>	<b>4.74</b>

**Table 4-23: 2017 HGB Area Non-Road Emissions Inventory by Fuel Type**

<b>Equipment Category</b>	<b>Equipment Population</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Two-Stroke Gasoline	722,354	0.45	12.85	47.14	0.00	0.89
Four-Stroke Gasoline	1,358,107	1.99	11.77	374.62	0.02	0.18
Diesel	130,329	30.57	3.47	16.14	0.04	2.39
Compressed Natural Gas (CNG)	1,871	0.27	0.10	1.28	0.00	0.01
Liquefied Petroleum Gas (LPG)	33,762	5.96	1.41	36.59	0.03	0.17
<b>HGB Total</b>	<b>2,246,423</b>	<b>39.23</b>	<b>29.59</b>	<b>475.77</b>	<b>0.10</b>	<b>3.64</b>

The eight-county HGB non-road emissions for 2012 and 2017, respectively, are summarized by the 25 DCE subcategory codes from Table 4-17 in Table 4-24: *2012 HGB Area Non-Road Emissions Inventory by Diesel Subcategory* and Table 4-25: *2017 HGB Area Non-Road Emissions Inventory by Diesel Subcategory*.

**Table 4-24: 2012 HGB Area Non-Road Emissions Inventory by Diesel Subcategory**

<b>Non-Road DCE Subsector</b>	<b>Equipment Population</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Non-Diesel Equipment	1,995,226	30.03	37.47	503.64	0.10	2.44
Agricultural Activities	781	0.68	0.07	0.43	0.00	0.07
Boring and Drilling Equipment	283	0.21	0.02	0.07	0.00	0.01
Brick and Stone Operations	83	0.15	0.01	0.07	0.00	0.01
City and County Road Construction	751	0.20	0.02	0.08	0.00	0.01
Commercial Construction	16,756	2.93	0.26	1.30	0.01	0.18
Concrete Operations	81	0.12	0.01	0.06	0.00	0.01
County-Owned Construction	284	0.15	0.01	0.07	0.00	0.01
Cranes	2,815	4.84	0.33	1.24	0.02	0.24
Heavy Highway Construction	646	0.60	0.05	0.27	0.00	0.05
Landfill Operations	137	0.49	0.04	0.20	0.00	0.04
Landscaping Activities	1,245	0.45	0.08	0.40	0.00	0.06
Manufacturing Operations	152	0.20	0.02	0.10	0.00	0.02
Municipal-Owned Construction	1,203	0.49	0.07	0.38	0.00	0.06
Transportation/Sales/Services	1,656	1.99	0.18	1.12	0.01	0.18
Residential Construction	2,085	2.33	0.18	0.95	0.01	0.17
Rough Terrain Forklifts	3,315	2.21	0.19	1.53	0.01	0.22
Scrap/Recycling Operations	168	0.26	0.02	0.11	0.00	0.02
Skid Steer Loaders	10,600	2.59	0.63	3.21	0.01	0.51
Special Trades Construction	84	0.03	0.00	0.02	0.00	0.00
Trenchers	5,261	3.00	0.23	1.89	0.01	0.25
TxDOT Construction Equipment	190	0.06	0.01	0.03	0.00	0.00
Utility Construction	2,659	0.76	0.06	0.32	0.00	0.05
Mining and Quarry Operations	78	0.19	0.02	0.07	0.00	0.01
Miscellaneous Equipment	4,772	1.61	0.17	0.87	0.00	0.12

Non-Road DCE Subsector	Equipment Population	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
HGB Total	2,051,311	56.58	40.13	518.44	0.17	4.74

**Table 4-25: 2017 HGB Area Non-Road Emissions Inventory by Diesel Subcategory**

Non-Road DCE Subsector	Equipment Population	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Non-Diesel Equipment	2,170,003	18.75	27.17	464.23	0.07	1.94
Agricultural Activities	729	0.33	0.04	0.20	0.00	0.03
Boring and Drilling Equipment	384	0.20	0.02	0.06	0.00	0.01
Brick and Stone Operations	108	0.08	0.01	0.04	0.00	0.01
City and County Road Construction	808	0.15	0.01	0.05	0.00	0.01
Commercial Construction	23,772	3.01	0.27	1.28	0.00	0.17
Concrete Operations	109	0.07	0.01	0.04	0.00	0.01
County-Owned Construction	307	0.11	0.01	0.05	0.00	0.01
Cranes	3,362	2.64	0.30	0.68	0.01	0.12
Heavy Highway Construction	901	0.44	0.05	0.20	0.00	0.03
Landfill Operations	148	0.15	0.03	0.05	0.00	0.01
Landscaping Activities	1,350	0.34	0.05	0.28	0.00	0.04
Manufacturing Operations	205	0.13	0.02	0.06	0.00	0.01
Municipal-Owned Construction	1,302	0.37	0.04	0.25	0.00	0.03
Transportation/Sales/Services	2,268	1.32	0.17	0.74	0.00	0.11
Residential Construction	2,701	1.59	0.16	0.66	0.00	0.12
Rough Terrain Forklifts	4,480	1.52	0.15	1.04	0.00	0.15
Scrap/Recycling Operations	188	0.09	0.02	0.03	0.00	0.00
Skid Steer Loaders	16,771	3.20	0.65	3.62	0.00	0.55
Special Trades Construction	131	0.03	0.00	0.02	0.00	0.00
Trenchers	7,141	2.62	0.19	1.17	0.00	0.14
TxDOT Construction Equipment	190	0.04	0.00	0.02	0.00	0.00
Utility Construction	3,740	0.77	0.06	0.30	0.00	0.04
Mining and Quarry Operations	47	0.04	0.01	0.01	0.00	0.00
Miscellaneous Equipment	5,280	1.26	0.14	0.67	0.00	0.09
HGB Total	2,246,423	39.23	29.59	475.77	0.10	3.64

The non-road emissions data output from TexN were prepared for photochemical modeling using EPS3. Table 4-26: *EPS3 Modules for Processing Non-Road Emissions* summarizes the steps that were taken to process the 2012 and 2017 non-road inventories.

**Table 4-26: EPS3 Modules for Processing Non-Road Emissions**

EPS3 Module	Description
PREAM	Convert text-based input files to binary format for further processing.



EPS3 Module	Description
CNTLEM	Apply adjustments for temperature/humidity NO <sub>x</sub> correction and TxLED.
TMPRL	Apply profiles to temporally allocate daily emission totals.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
GRDEM	Spatially allocate emissions with surrogates and prepare model inputs.
MARGUAM	Merge and adjust multiple gridded files for photochemical model input.

When running a summer weekday scenario, the NONROAD model reports 24-hour emission totals and does not account for the effects of hourly variation in temperature and humidity on NO<sub>x</sub> emissions. Greater detail on the development of correction equations to account for these effects can be found in Appendices [F.4](#) and [F.5](#) of the [December 2004 HGB SIP revision](#). During EPS3 processing, the CNTLEM module is used to apply an hourly temperature/humidity NO<sub>x</sub> correction and the impacts on the 2012 and 2017 non-road HGB inventories are presented in Table 4-27: *Temperature/Humidity NO<sub>x</sub> Correction for Non-Road Emissions*.

**Table 4-27: Temperature/Humidity NO<sub>x</sub> Correction for Non-Road Emissions**

Calendar Year	Temperature/Humidity NO <sub>x</sub> Correction (tpd)
2012	3.88
2017	2.92

The 2012 and 2017 non-road NO<sub>x</sub> emission totals presented above in Table 4-18 through Table 4-25 exclude the benefits of Texas Low Emission Diesel (TxLED) fuel. Instead, TxLED benefits were accounted for by applying a NO<sub>x</sub> reduction to the diesel non-road equipment categories through use of the EPS3 CNTLEM module. The specific adjustment factors vary by horsepower range and certification standard, as summarized in Table 4-28: *Non-Road TxLED Adjustments by Horsepower and Standard*. More detail on development of the post-processing adjustments can be found in the September 27, 2001 EPA memorandum [Texas Low Emission Diesel \(LED\) Fuel Benefits](#).

**Table 4-28: Non-Road TxLED Adjustments by Horsepower and Standard**

Non-Road Diesel Equipment Standard/Category	TxLED NO <sub>x</sub> Reduction Factor
Under 50 Horsepower	0.0%
Base, Tier 0, Tier 1, and Tier 2	6.2%
Tier 3 and Tier 4	4.8%

The 2012 and 2017 non-road TxLED benefits for the eight-county HGB area are presented in Table 4-29: *2012 and 2017 HGB Area Non-Road TxLED Benefits*.

**Table 4-29: 2012 and 2017 HGB Area Non-Road TxLED Benefits**

Calendar Year	TxLED NO <sub>x</sub> Reduction (tpd)
2012	1.91

Calendar Year	TxLED NO <sub>x</sub> Reduction (tpd)
2017	1.34

The activity level for different non-road equipment varies between weekday and weekend day types. For example, commercial construction equipment is more commonly used on weekdays than weekends. Conversely, recreational boats are more commonly used on weekends than on weekdays. The EPS3 TMPRL module is used to adjust the average weekday emissions by equipment type for creating Saturday and Sunday day types. Within each day type, TMPRL also allocates daily totals to each hour. After the CNTLEM and TMPRL adjustments are made, the EPS3 GRDEM module is used to spatially allocate the non-road emissions with surrogates that vary based on SCC. The files output from GRDEM are in the binary gridded format required by the photochemical model. The 2012 and 2017 non-road emissions output from GRDEM by day type for the eight-county HGB area are respectively summarized in Table 4-30: *2012 HGB Area Non-Road Emissions Inventory by Day Type* and Table 4-31: *2017 HGB Area Non-Road Emissions Inventory by Day Type*.

**Table 4-30: 2012 HGB Area Non-Road Emissions Inventory by Day Type**

2012 Day Type	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Monday – Friday Average Weekday	50.78	40.11	518.13	0.17	4.25
Saturday	37.69	77.62	678.12	0.14	3.19
Sunday	28.07	71.67	590.95	0.11	2.51

**Table 4-31: 2017 HGB Area Non-Road Emissions Inventory by Day Type**

2017 Day Type	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Monday – Friday Average Weekday	34.97	29.57	475.47	0.10	3.16
Saturday	26.60	53.93	633.37	0.09	2.34
Sunday	20.40	50.01	561.19	0.07	1.85

Comparing Table 4-30 and Table 4-31 with Table 4-18 through Table 4-25 indicates that the weekday VOC, CO, and SO<sub>2</sub> totals remain unchanged, while the weekday NO<sub>x</sub> totals are reduced by the temperature/humidity and TxLED adjustments presented in Table 4-27 and Table 4-29. The PM<sub>2.5</sub> totals are also slightly lower in Table 4-30 and Table 4-31 because they include only organic carbon, elemental carbon, and sulfate (SO<sub>4</sub>). The PM<sub>2.5</sub> emissions from gasoline, compressed natural gas (CNG), and liquefied petroleum gas (LPG) equipment were allocated to these PM<sub>2.5</sub> categories based on profiles from the [EPA SPECIATE Database](#). The amount allocated to these categories for diesel engines varies based on whether exhaust after-treatment is needed to meet applicable standards. To obtain these diesel PM<sub>2.5</sub> factors, the [MOVES2014a model](#) was run in default mode to obtain contributions by model year group for 2006-and-older and 2010-and newer diesel vehicles. The former group did not need after-treatment while the latter group does, and the 2007 through 2009 model years were not included in the analysis because they are transition years for the tighter standards. These PM<sub>2.5</sub>

allocation methods are summarized in Table 4-32: *Speciation of Non-Road PM<sub>2.5</sub> Emissions*.

**Table 4-32: Speciation of Non-Road PM<sub>2.5</sub> Emissions**

Non-Road Fuel Type and/or Standard	PM <sub>2.5</sub> Allocation Approach
Gasoline	SPECIATE profile 92113 for non-road gasoline exhaust
CNG and LPG	SPECIATE profile 92112 for natural gas combustion
Diesel – Base and Tiers 0-3	MOVES2014a default runs for 2006-and-older without after-treatment
Diesel – Tier 4	MOVES2014a default for 2010-and-newer with after-treatment

For the non-HGB areas of Texas, the steps described above are similar for the TexN development and EPS3 processing of non-road emission estimates for 2012 and 2017. The EPS3 processing for Texas non-road emissions is divided into streams for:

- the eight-county HGB area;
- the 10-county DFW area;
- the remaining 92 of all 110 eastern Texas counties subject to TxLED; and
- the 144 counties of western Texas not subject to TxLED.

The non-road EPS3 processing streams for non-road sources are available for both [2012](#) and [2017](#) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/nonroad/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/nonroad/tex/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/nonroad/tex/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/nonroad/tex/), respectively. The following pages contain graphical plots of the 2012 and 2017 summer weekday non-road NO<sub>x</sub> and VOC emissions for the HGB area. These plots are respectively titled Figure 4-11: *2012 Summer Weekday HGB Non-Road NO<sub>x</sub> Emissions Distribution*, Figure 4-12: *2012 Summer Weekday HGB Non-Road VOC Emissions Distribution*, Figure 4-13: *2017 Summer Weekday HGB Non-Road NO<sub>x</sub> Emissions Distribution*, and Figure 4-14: *2017 Summer Weekday HGB Non-Road VOC Emissions Distribution*.

For the non-Texas U.S. areas of the modeling domain, the [EPA National Mobile Inventory Model \(NMIM\)](#) was run for 2012 and 2017 to obtain non-road emission estimates for each county. The NMIM output was processed through EPS3 in a manner similar to that described above for non-road emissions within Texas.

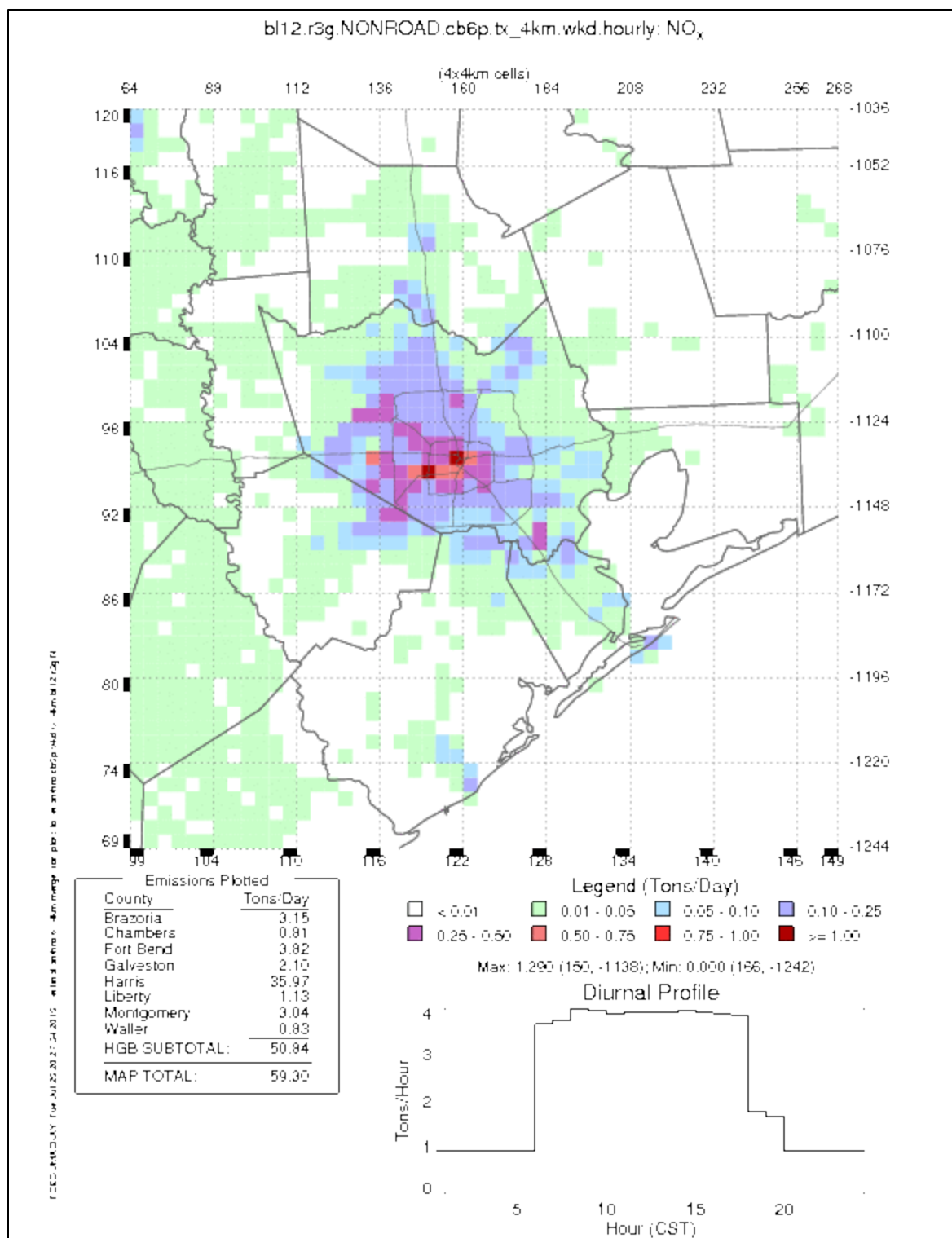


Figure 4-11: 2012 Summer Weekday HGB Non-Road NO<sub>x</sub> Emissions Distribution

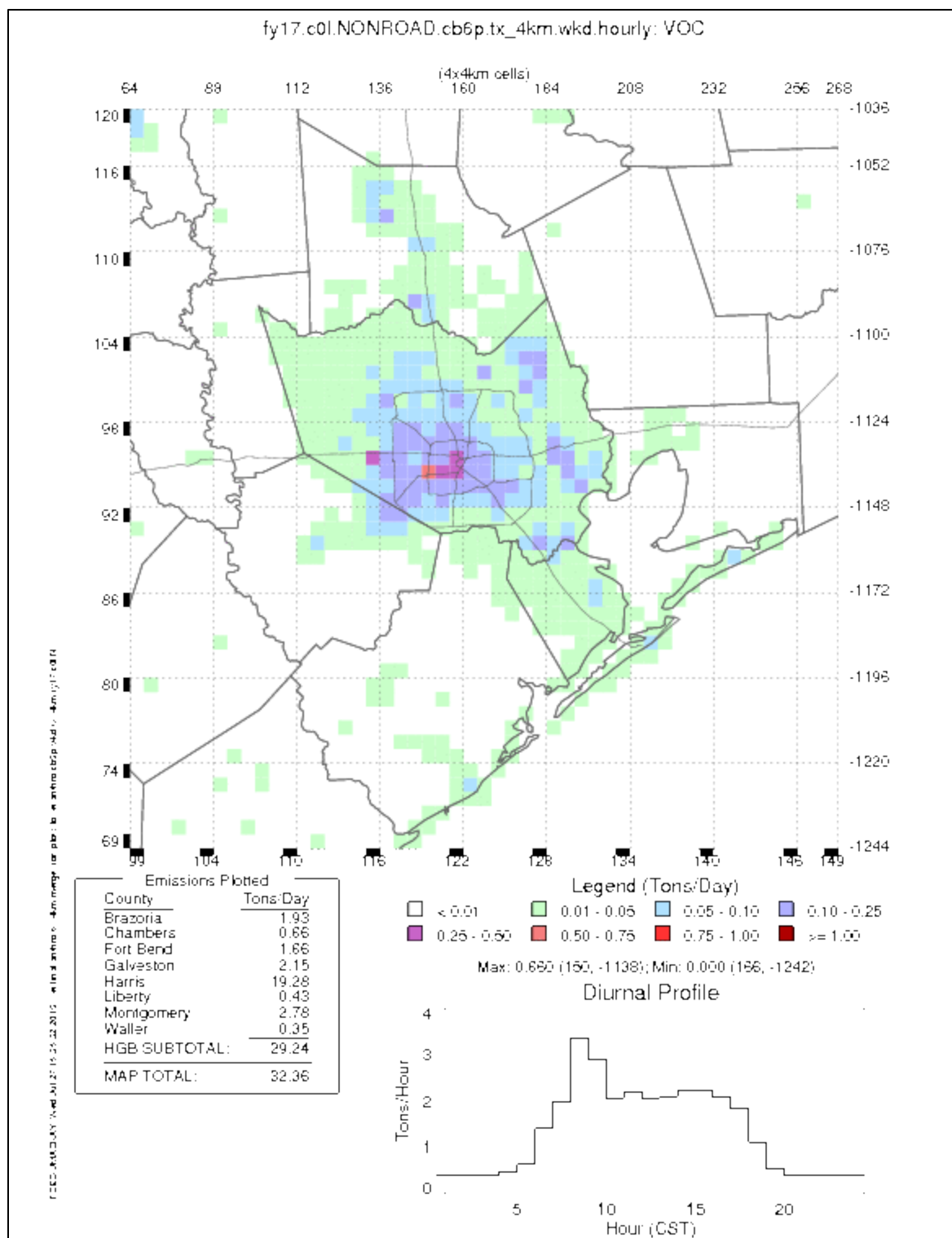


Figure 4-12: 2012 Summer Weekday HGB Non-Road VOC Emissions Distribution

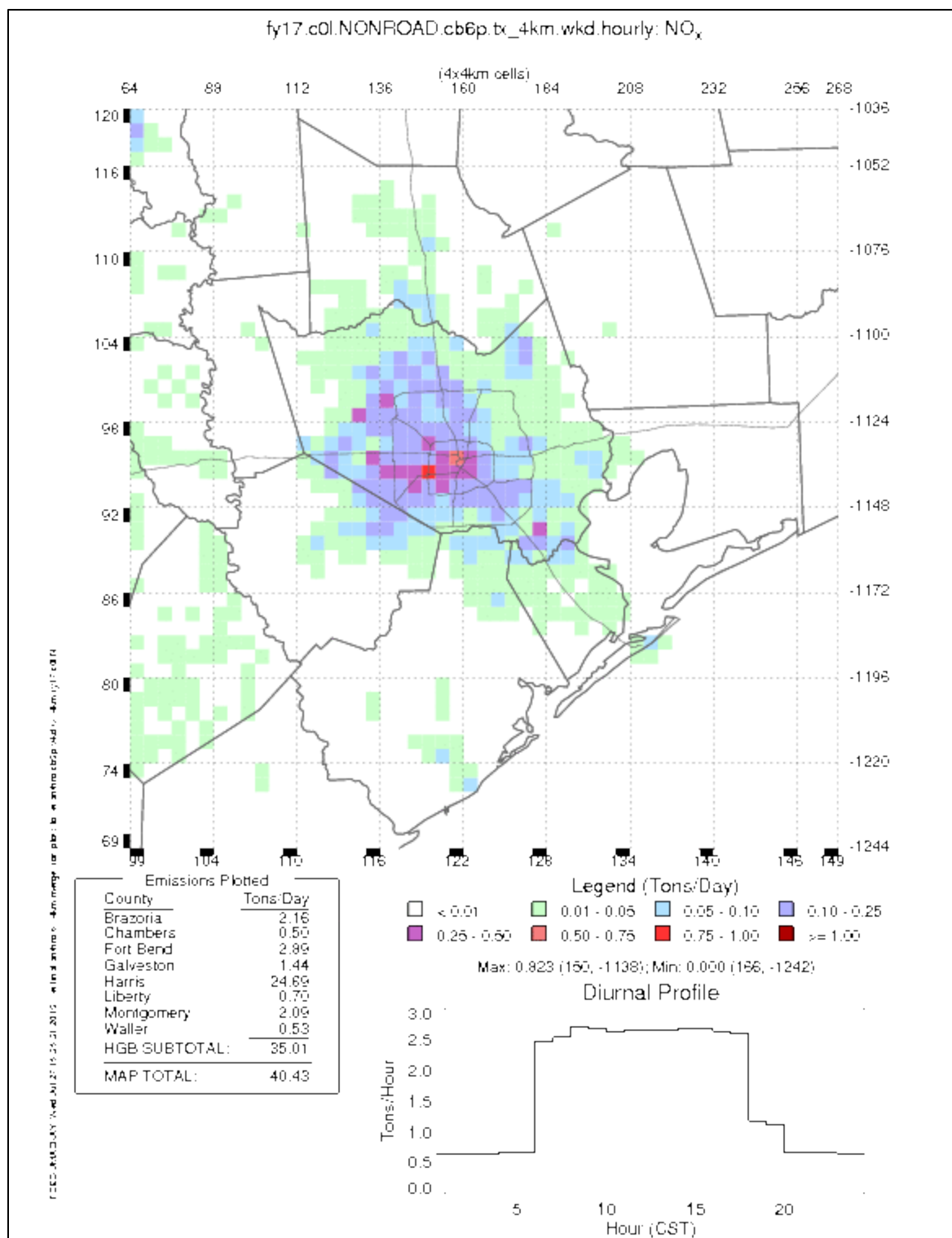


Figure 4-13: 2017 Summer Weekday HGB Non-Road NO<sub>x</sub> Emissions Distribution

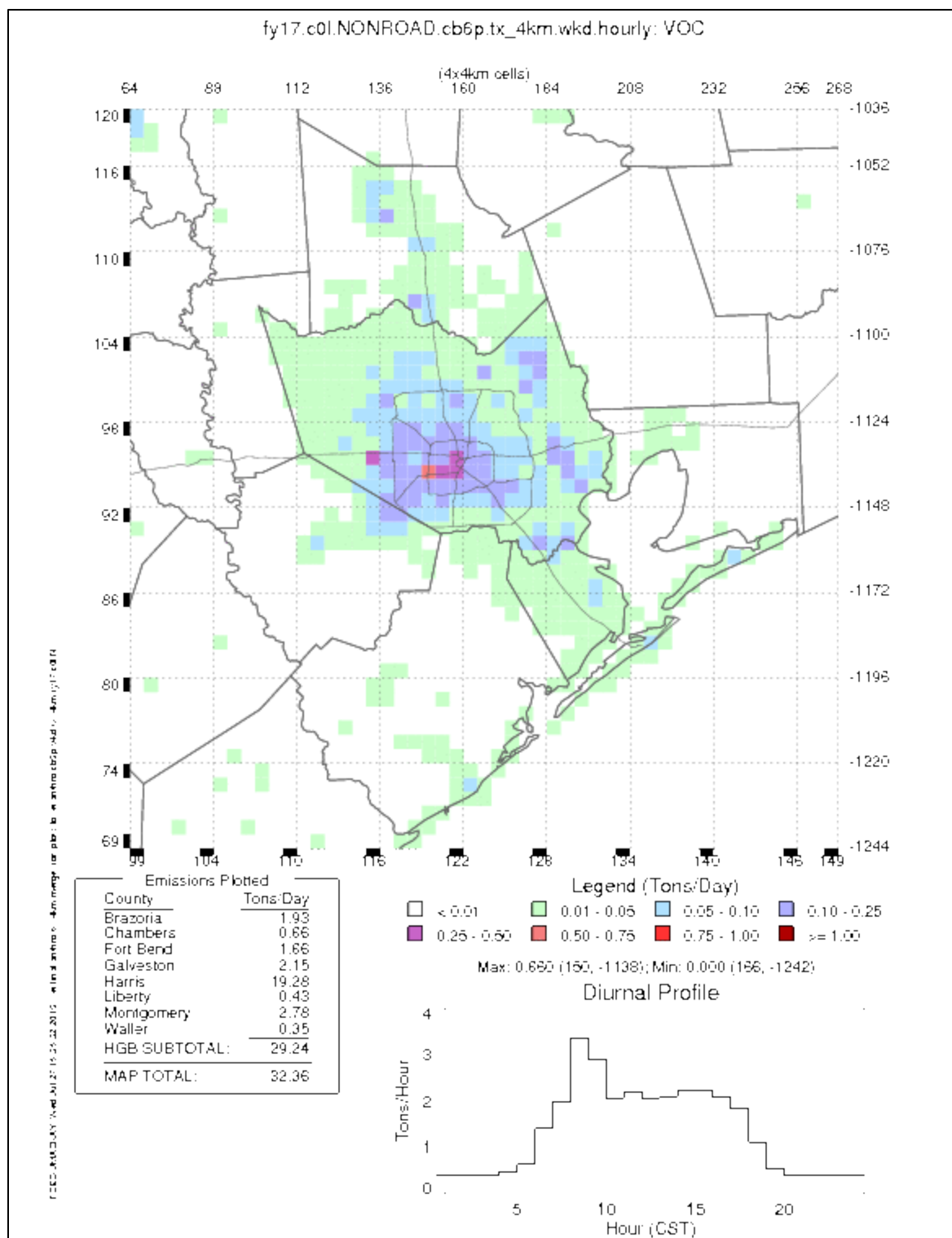


Figure 4-14: 2017 Summer Weekday HGB Non-Road VOC Emissions Distribution

#### 4.5 AREA SOURCES

Area sources include commercial, small-scale industrial, and residential activities that use materials or operate processes that can generate emissions. These sources of emissions fall below the point source reporting levels and are either too numerous or too small to identify individually. Emissions from these sources are estimated on a source category basis per county. Area source VOC emissions can result from either evaporation or fuel combustion. Examples of sources of evaporative losses include printing operations, industrial coatings, degreasing solvents, house paints, underground storage tanks, underground tank filling at gasoline service stations, and vehicle refueling operations. Fuel combustion sources include stationary source fossil fuel combustion at residences and businesses, along with outdoor burning and structural fires. With some exceptions, area source emission estimates are obtained by multiplying an established emission factor by the appropriate activity or activity surrogate responsible for generating the emissions. Human population is the most commonly used activity surrogate for many area source categories, while other activity data include the amount of gasoline sold in an area, employment by industry type, acres of cropland, etc. Area source modeling estimates were based primarily on data from the 2011 and 2014 periodic emissions inventories, which are available via [TexAER](http://www.tceq.state.tx.us/airquality/areasource/TexAER.html) at <http://www.tceq.state.tx.us/airquality/areasource/TexAER.html>.

The NO<sub>x</sub>, VOC, CO, SO<sub>2</sub>, NH<sub>3</sub>, and PM<sub>2.5</sub> area source emissions by county from TexAER for 2011 and 2014, respectively, are presented below in Table 4-33: *2011 HGB Area Source Emissions Inventory by County* and Table 4-34: *2014 HGB Area Source Emissions Inventory by County*.

**Table 4-33: 2011 HGB Area Source Emissions Inventory by County**

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Brazoria	1.60	18.46	23.22	0.04	6.28	13.68
Chambers	0.14	1.92	0.88	0.04	1.54	3.25
Fort Bend	1.42	15.76	2.90	0.28	3.92	10.30
Galveston	0.88	9.81	1.93	0.13	0.88	4.34
Harris	15.92	167.93	23.74	3.61	13.08	34.75
Liberty	0.29	4.03	3.13	0.03	3.52	5.64
Montgomery	2.20	16.62	31.08	0.26	3.10	21.41
Waller	0.23	1.64	2.44	0.05	3.09	2.48
HGB Total	22.68	236.17	89.34	4.45	35.40	95.84

**Table 4-34: 2014 HGB Area Source Emissions Inventory by County**

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Brazoria	1.57	18.39	19.90	0.50	5.41	12.72
Chambers	0.16	1.98	1.54	0.08	1.32	3.06
Fort Bend	1.50	15.23	3.71	0.49	3.01	9.48
Galveston	0.89	9.84	2.31	0.24	1.76	3.83
Harris	16.36	157.61	22.05	6.54	11.79	34.29



HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Liberty	0.32	3.89	4.51	0.07	2.20	7.43
Montgomery	2.22	17.28	33.53	0.44	1.76	19.49
Waller	0.22	1.54	1.32	0.11	2.22	4.03
HGB Total	23.24	225.75	88.89	8.48	29.47	94.34

The 2011 and 2014 area source emissions data from TexAER were prepared for photochemical modeling using EPS3. Table 4-35: *EPS3 Modules for Processing Area Source Emission Inventories* summarizes the steps that were taken to prepare the 2012 and 2017 area source emission inventories.

**Table 4-35: EPS3 Modules for Processing Area Source Emission Inventories**

EPS3 Module	Description
PREAM	Convert text-based input files to binary format for further processing.
CNTLEM	Project 2011 emissions to 2012, and 2014 emissions to 2017.
SPCEMS	Chemically speciate VOC emissions into olefins, paraffins, etc.
TMPRL	Apply profiles to temporally allocate daily emission totals.
GRDEM	Spatially allocate emissions with surrogates and prepare model inputs.
MRGUAM	Merge and adjust multiple gridded files for photochemical model input.

As shown, the EPS3 CNTLEM module was used to project 2011 HGB area source emission estimates from TexAER to 2012, and to project the 2014 HGB area source emission estimates to 2017. In both cases, a study done under contract by ERG was conducted to develop growth factors from 2005 through 2030 based on data available from [Moody's Analytics](#) and the [U.S. EIA](#). More detail on this analysis is available within TexAER. Based on natural gas usage patterns from the U.S. EIA, temporal profiles were developed and applied to allocate less emissions during summer months when natural gas consumption is lower than other times of the year. The adjusted NO<sub>x</sub>, VOC, CO, SO<sub>2</sub>, NH<sub>3</sub>, and PM<sub>2.5</sub> area source emissions for 2012 and 2017, respectively, by county are presented below in Table 4-36: *2012 HGB Area Source Emissions Inventories by County* and Table 4-37: *2017 HGB Area Source Emission Inventories by County*.

**Table 4-36: 2012 HGB Area Source Emissions Inventories by County**

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Brazoria	1.65	20.69	30.25	0.04	6.27	14.30
Chambers	0.13	2.09	0.98	0.05	1.54	3.27
Fort Bend	1.08	18.67	1.94	0.33	3.92	10.21
Galveston	0.60	11.60	1.19	0.15	0.88	4.25
Harris	13.12	197.98	14.55	4.23	13.03	33.68
Liberty	0.25	4.77	3.80	0.04	3.52	5.74
Montgomery	2.23	20.27	41.21	0.30	3.09	22.35
Waller	0.23	1.89	2.82	0.07	3.09	2.53

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
HGB Total	19.28	277.97	96.73	5.22	35.34	96.33

**Table 4-37: 2017 HGB Area Source Emission Inventories by County**

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Brazoria	1.53	20.30	23.05	0.52	5.39	13.38
Chambers	0.15	2.17	1.58	0.08	1.32	3.19
Fort Bend	1.12	17.97	1.89	0.51	2.99	9.47
Galveston	0.57	11.57	1.14	0.25	1.72	3.68
Harris	13.13	185.35	13.04	6.86	11.35	32.52
Liberty	0.29	4.58	4.82	0.07	2.20	7.70
Montgomery	2.21	20.87	40.24	0.47	1.75	20.71
Waller	0.22	1.82	1.34	0.11	2.22	4.25
HGB Total	19.21	264.62	87.10	8.88	28.94	94.90

The eight-county HGB area source emissions inventory includes 174 different types of SCCs. The eight-county HGB aggregate SCC categories for the area source emissions are summarized for 2012 and 2017, respectively, in Table 4-38: *2012 HGB Area Source Emission Inventories by Aggregate Category* and Table 4-39: *2017 HGB Area Source Emission Inventories by Aggregate Category*.

**Table 4-38: 2012 HGB Area Source Emission Inventories by Aggregate Category**

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Agricultural Production	0.07	0.38	2.42	0.00	24.09	3.69
Catastrophic/Accidental Releases	0.00	0.46	0.00	0.00	0.00	0.00
Chemical Transport	0.00	3.53	0.00	0.00	0.00	0.00
Commercial/Institutional	4.54	86.09	2.75	0.13	0.03	0.09
Construction	0.00	0.00	0.00	0.00	0.00	20.99
Degreasing	0.00	10.55	0.00	0.00	0.00	0.00
Dry Cleaning	0.00	0.02	0.00	0.00	0.00	0.00
Fabricated Metals	0.00	0.95	0.00	0.00	0.00	0.00
Food and Kindred Products	0.00	1.27	1.71	0.00	0.00	4.61
Graphic Arts	0.00	15.29	0.00	0.00	0.00	0.00
Incineration, Burning, and Combustion	2.44	5.48	75.81	0.07	0.00	7.62
Industrial	9.82	7.99	6.75	4.99	0.37	0.29
Landfills	0.00	3.71	0.00	0.00	0.00	0.00
Petroleum Refining, Storage, and Transport	0.00	76.75	0.03	0.00	0.00	0.00
Residential	2.41	1.16	7.27	0.03	0.06	1.02
Roads - Paved and Unpaved	0.00	0.00	0.00	0.00	0.00	58.04
Rubber/Plastics	0.00	2.48	0.00	0.00	0.00	0.00

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Secondary Metal Production	0.00	0.00	0.00	0.00	0.00	0.00
Surface Coating	0.00	61.41	0.00	0.00	0.00	0.00
Underground Storage Tanks	0.00	0.11	0.00	0.00	0.00	0.00
Waste Animal Emissions	0.00	0.00	0.00	0.00	10.72	0.00
Wastewater Treatment	0.00	0.32	0.00	0.00	0.06	0.00
HGB Total	19.28	277.97	96.73	5.22	35.34	96.33

**Table 4-39: 2017 HGB Area Source Emission Inventories by Aggregate Category**

HGB Area County	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Agricultural Production	0.20	0.33	4.68	0.08	16.62	3.72
Catastrophic/Accidental Releases	0.00	0.46	0.00	0.00	0.00	0.00
Chemical Transport	0.00	3.62	0.00	0.00	0.00	0.00
Commercial/Institutional	3.55	89.97	2.43	0.38	0.00	0.01
Construction	0.00	0.00	0.00	0.00	0.00	23.24
Degreasing	0.00	12.00	0.00	0.00	0.00	0.00
Dry Cleaning	0.00	0.09	0.00	0.00	0.00	0.00
Fabricated Metals	0.00	0.97	0.00	0.00	0.00	0.00
Food and Kindred Products	0.00	1.42	1.90	0.00	0.00	4.70
Graphic Arts	0.00	0.74	0.00	0.00	0.00	0.00
Incineration, Burning, and Combustion	2.11	4.67	64.58	0.06	0.00	6.47
Industrial	11.23	9.60	7.95	8.34	0.35	0.31
Landfills	0.00	3.93	0.00	0.00	0.00	0.00
Mining and Quarrying	0.00	0.00	0.00	0.00	0.00	0.41
Petroleum Refining, Storage, and Transport	0.00	70.76	0.04	0.00	0.00	0.00
Residential	2.12	0.94	5.52	0.02	0.45	0.72
Roads - Paved and Unpaved	0.00	0.00	0.00	0.00	0.00	55.31
Rubber/Plastics	0.00	2.44	0.00	0.00	0.00	0.00
Secondary Metal Production	0.00	0.00	0.00	0.00	0.00	0.00
Surface Coating	0.00	62.15	0.00	0.00	0.00	0.00
Underground Storage Tanks	0.00	0.16	0.00	0.00	0.00	0.00
Waste Animal Emissions	0.00	0.00	0.00	0.00	11.45	0.00
Wastewater Treatment	0.00	0.37	0.00	0.00	0.07	0.00
HGB Total	19.21	264.62	87.10	8.88	28.94	94.90

The activity level for different area source categories differs between weekday and weekend day types. The EPS3 TMPRL module is used to adjust the average weekday emissions by SCC for creating Saturday and Sunday day types. Within each day type, TMPRL also allocates daily totals to each hour. After the CNTLEM and TMPRL adjustments are made, the EPS3 GRDEM module is used to spatially allocate the area source emissions with surrogates that vary based on SCC. For example, residential fuel

use emissions are spatially allocated to grid cells as a function of households. The files output from GRDEM are in the binary gridded format required by the photochemical model. The area source output from GRDEM by day type for the eight-county HGB area are summarized for 2012 and 2017, respectively, in Table 4-40: *2012 HGB Area Source Emission Inventories by Day Type* and Table 4-41: *2017 HGB Area Source Emission Inventories by Day Type*.

**Table 4-40: 2012 HGB Area Source Emission Inventories by Day Type**

<b>2012 Day Type</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>NH<sub>3</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Monday – Friday Average Weekday	19.28	277.97	96.73	5.22	35.34	96.33
Saturday	13.75	162.69	56.16	3.65	35.22	92.42
Sunday	8.24	113.70	16.41	2.08	35.10	88.58

**Table 4-41: 2017 HGB Area Source Emission Inventories by Day Type**

<b>2017 Day Type</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>VOC (tpd)</b>	<b>CO (tpd)</b>	<b>SO<sub>2</sub> (tpd)</b>	<b>NH<sub>3</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>
Monday – Friday Average Weekday	19.21	264.62	87.10	8.88	28.94	94.90
Saturday	13.74	164.06	51.95	6.24	28.83	91.62
Sunday	8.29	115.03	17.50	3.60	28.73	88.42

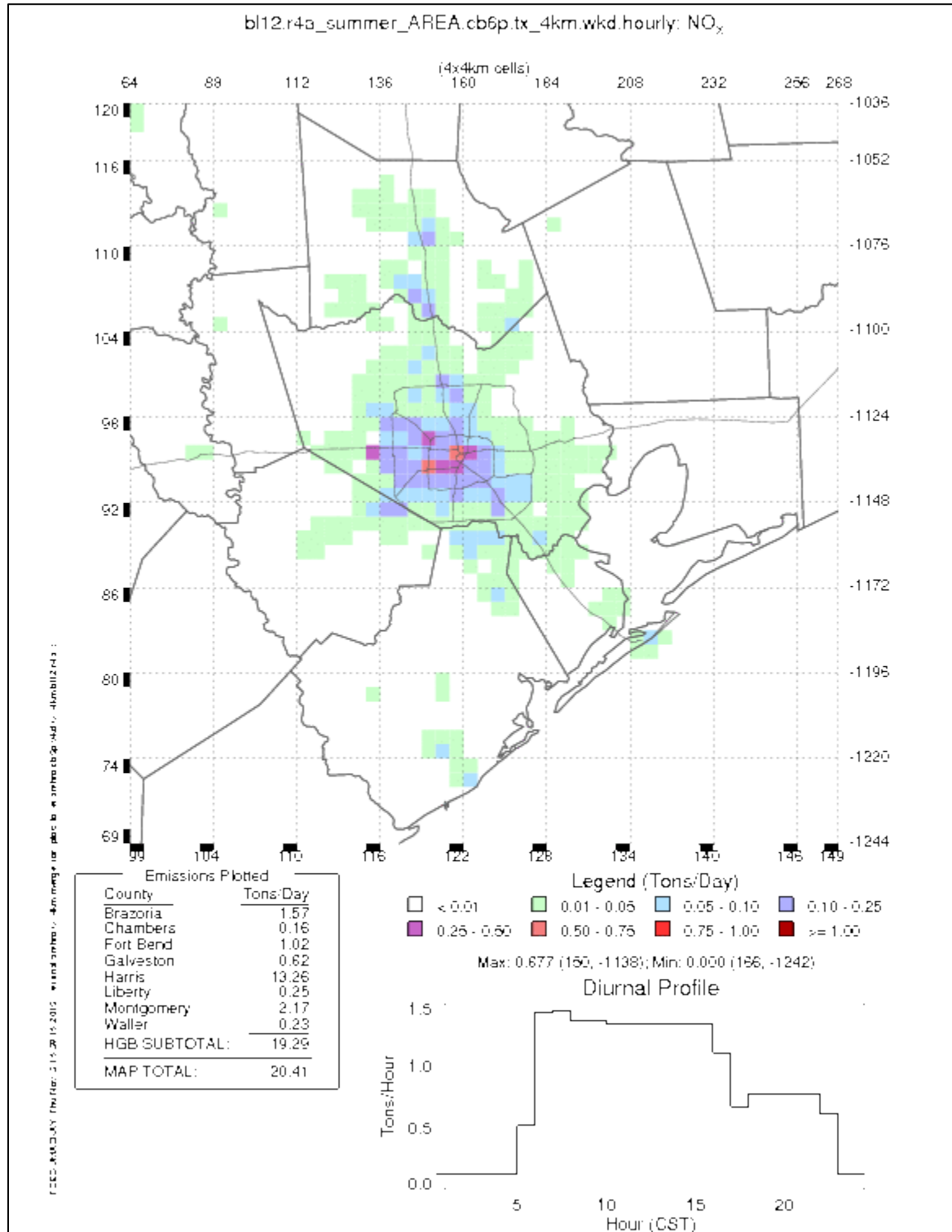
For the non-HGB areas of Texas, the steps described above are similar for the area source emissions inventory development where TexAER datasets from 2011 and 2014 were adjusted to create 2012 and 2017 inventories, respectively. The EPS3 processing for Texas area source emissions is divided into streams for:

- the eight-county HGB area;
- the 10-county DFW area;
- the remaining 236 counties of Texas outside of DFW and HGB.

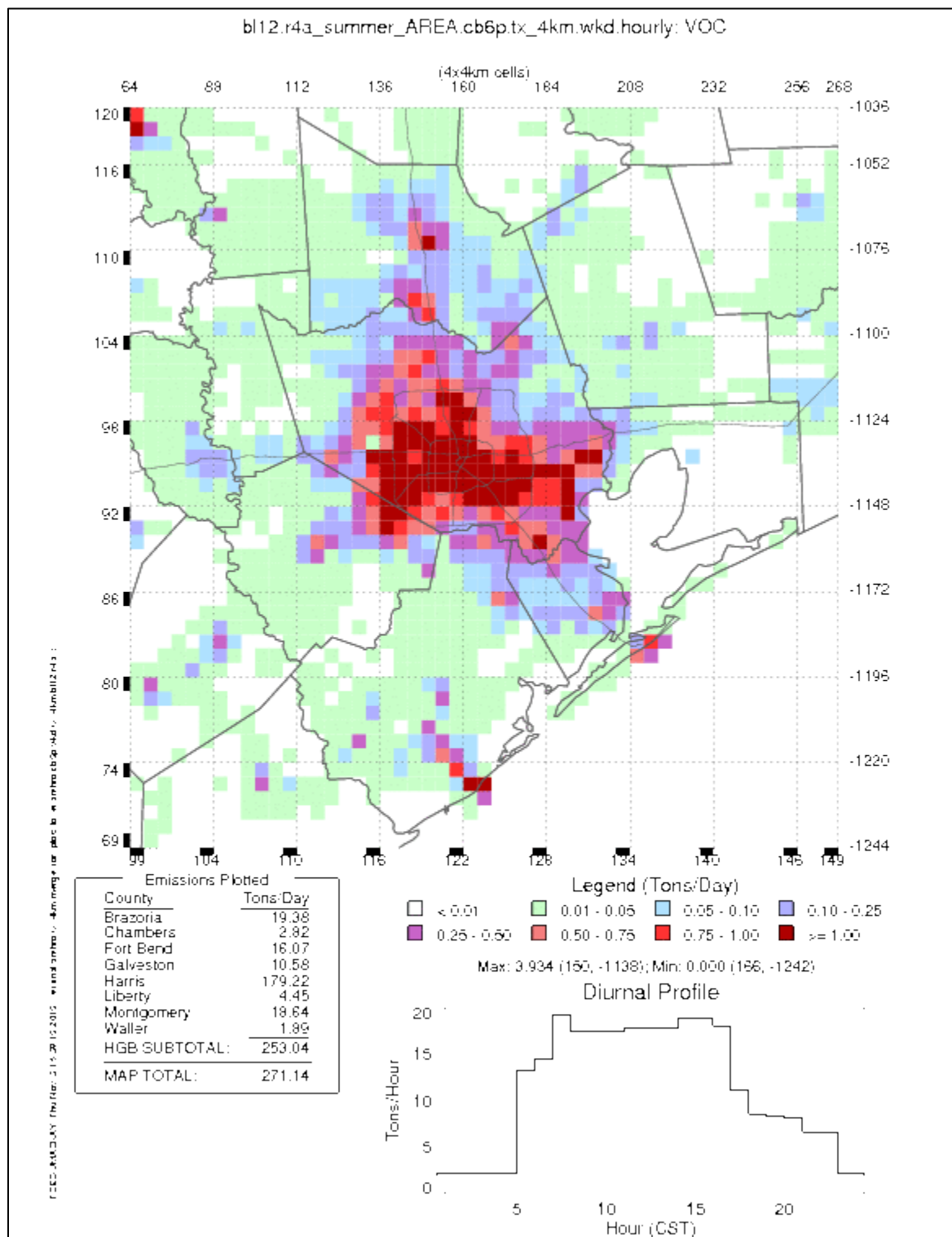
The complete EPS3 processing streams for the area sources are available for both [2012](#) and [2017](#) at [http://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/area/tex/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/area/tex/) and [http://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/area/tex/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/area/tex/), respectively. The following pages contain graphical plots of the 2012 and 2017 area source NO<sub>x</sub> and VOC emissions for the HGB area. These plots are respectively titled Figure 4-15: *2012 HGB Area Source NO<sub>x</sub> Emissions Distribution*, Figure 4-16: *2012 HGB Area Source VOC Emissions Distribution*, Figure 4-17: *2017 HGB Area Source NO<sub>x</sub> Emissions Distribution*, and Figure 4-18: *2017 HGB Area Source VOC Emissions Distribution*.

For the non-Texas U.S. areas of the modeling domain, area source emission estimates from the EPA [NEI](#) were used. The [2011 area source NEI](#) was projected to 2012 and 2017 to develop the non-Texas inputs. The area source emission estimates from the NEI datasets were processed through EPS3 in a manner similar to that described above for the area source emissions within Texas. The non-Texas EPS3 processing streams for area sources for both [2012](#) and [2017](#) are available at [http://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/area/usa/](http://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/area/usa/)

and  
[ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/area/usa/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/area/usa/),  
 respectively.



**Figure 4-15: 2012 HGB Area Source NO<sub>x</sub> Emissions Distribution**



**Figure 4-16: 2012 HGB Area Source VOC Emissions Distribution**

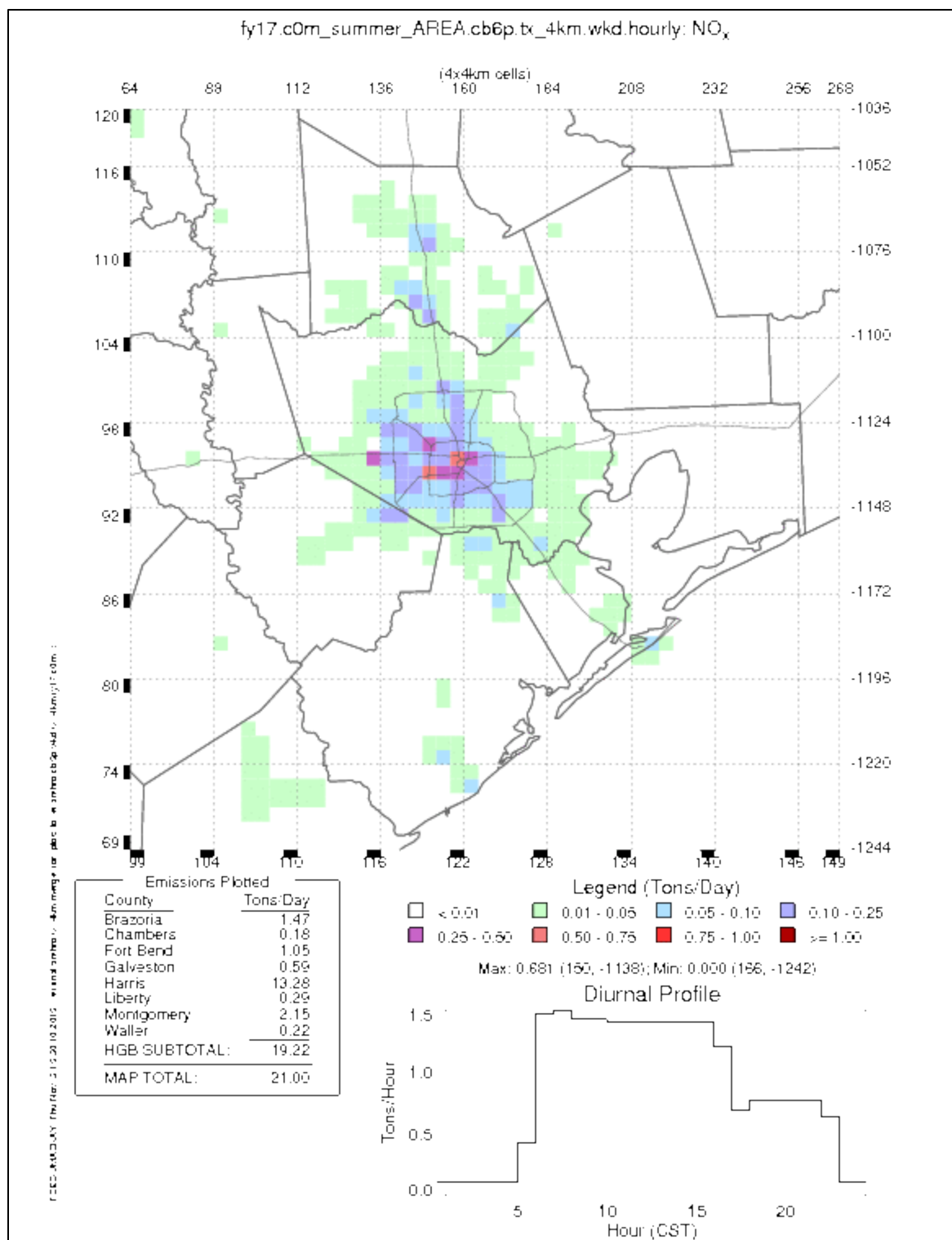


Figure 4-17: 2017 HGB Area Source NO<sub>x</sub> Emissions Distribution

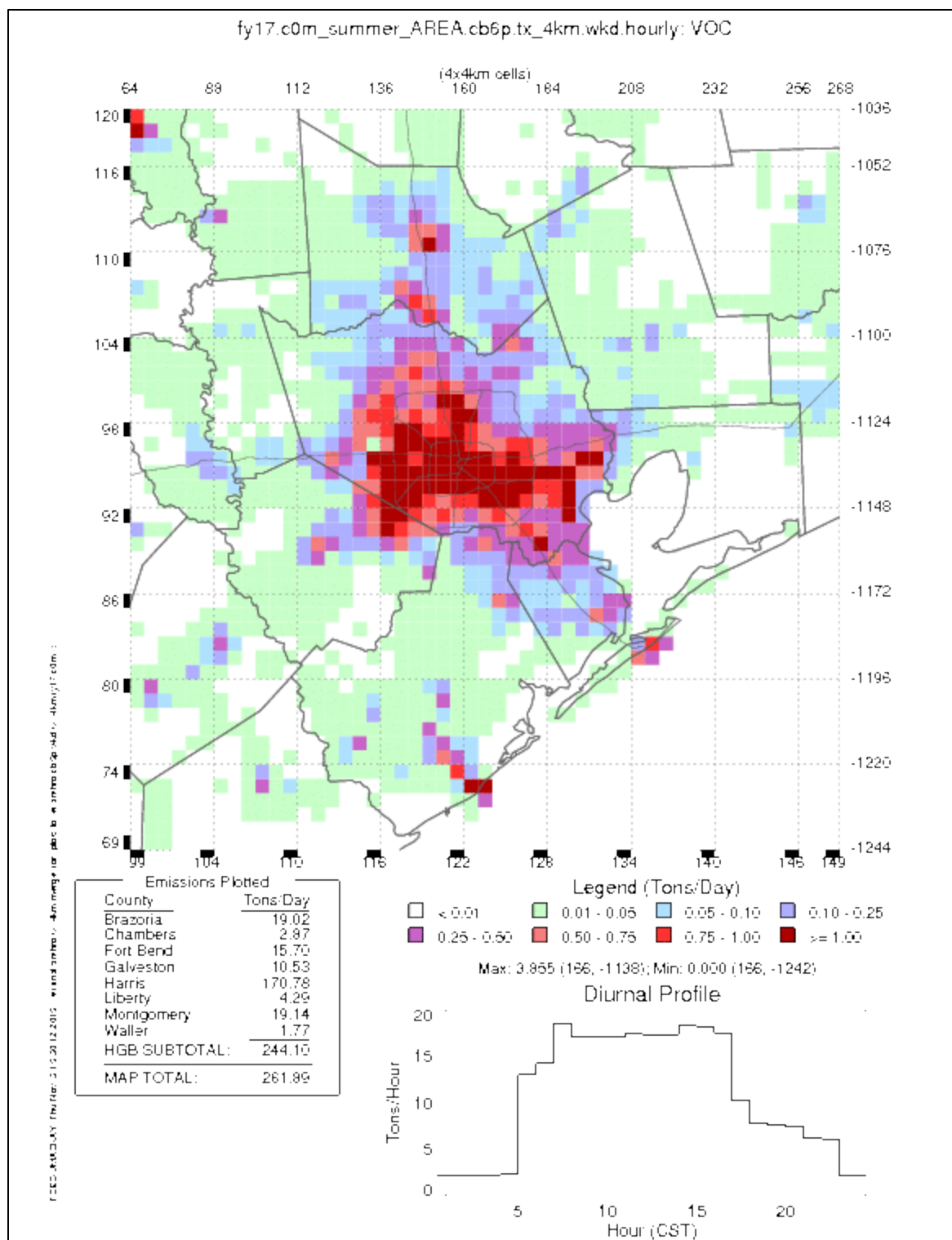


Figure 4-18: 2017 HGB Area Source VOC Emissions Distribution



#### 4.6 COMMERCIAL MARINE EMISSIONS

Commercial marine emission estimates were developed under contract to Ramboll-Environ and detailed in [Implement Port of Houston's Current Inventory and Harmonize the Remaining 8-county Shipping Inventory for TCEQ Modeling](https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5820784006FY1005-20100818-enviro-HGBShipsEI.pdf), which is available at <https://www.tceq.texas.gov/assets/public/implementation/air/am/contracts/reports/ei/5820784006FY1005-20100818-enviro-HGBShipsEI.pdf>. The emission estimates were projected to 2012 and 2017 based on expected changes in shipping activity and reductions in emission rates from engine turnover. The 2012 and 2017 eight-county HGB commercial marine emission estimates by vessel type are summarized in Table 4-42: 2012 HGB Commercial Marine Emissions by Source Category and Table 4-43: 2017 HGB Commercial Marine Emissions by Source Category, respectively.

**Table 4-42: 2012 HGB Commercial Marine Emissions by Source Category**

Commercial Marine Source Classification Description	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Chemical Tanker	8.75	0.43	0.92	21.90	0.00	1.30
Tow Boat	5.05	0.22	1.60	0.11	0.00	0.26
Crude Tanker	2.95	0.15	0.31	6.75	0.00	0.41
General Cargo	2.16	0.10	0.22	2.60	0.00	0.22
Container Ship	2.07	0.14	0.26	1.82	0.00	0.19
Bulk	1.63	0.08	0.17	1.50	0.00	0.14
LNG/LPG Tanker	1.29	0.05	0.13	1.42	0.00	0.13
Ocean Towing	0.78	0.04	0.08	0.01	0.00	0.02
Dredging	0.70	0.03	0.25	0.01	0.00	0.04
Auto Carrier	0.68	0.03	0.07	0.55	0.00	0.06
Refrigerated Cargo	0.38	0.01	0.04	0.36	0.00	0.04
Other Tanker	0.37	0.02	0.04	0.31	0.00	0.03
Tug Barge	0.31	0.02	0.04	0.01	0.00	0.01
Cruise Ship	0.27	0.01	0.03	0.27	0.00	0.02
Harbor Vessel	0.20	0.01	0.04	0.00	0.00	0.01
Miscellaneous	0.13	0.01	0.01	0.11	0.00	0.01
Assist Tug	0.02	0.00	0.01	0.00	0.00	0.00
Drill Rig	0.00	0.00	0.00	0.00	0.00	0.00
Military	0.00	0.00	0.00	0.00	0.00	0.00
HGB Total	27.74	1.33	4.21	37.73	0.00	2.89

**Table 4-43: 2017 HGB Commercial Marine Emissions by Source Category**

Commercial Marine Source Classification Description	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Chemical Tanker	7.21	0.44	0.93	5.41	0.00	0.20
Tow Boat	4.44	0.20	1.66	0.02	0.00	0.21
Crude Tanker	2.47	0.15	0.32	1.69	0.00	0.07
Container Ship	2.00	0.16	0.31	0.53	0.00	0.04
General Cargo	1.93	0.11	0.24	0.69	0.00	0.04

Commercial Marine Source Classification Description	NO <sub>x</sub> (tpd)	VOC (tpd)	CO (tpd)	SO <sub>2</sub> (tpd)	NH <sub>3</sub> (tpd)	PM <sub>2.5</sub> (tpd)
Bulk	1.42	0.08	0.18	0.39	0.00	0.02
LNG/LPG Tanker	1.07	0.06	0.13	0.35	0.00	0.02
Ocean Towing	0.69	0.04	0.09	0.00	0.00	0.00
Auto Carrier	0.63	0.03	0.07	0.15	0.00	0.01
Dredging	0.55	0.03	0.24	0.00	0.00	0.03
Refrigerated Cargo	0.34	0.02	0.04	0.10	0.00	0.01
Other Tanker	0.33	0.02	0.04	0.08	0.00	0.01
Tug Barge	0.27	0.01	0.04	0.00	0.00	0.01
Cruise Ship	0.21	0.01	0.02	0.06	0.00	0.00
Harbor Vessel	0.18	0.01	0.04	0.00	0.00	0.01
Miscellaneous	0.12	0.01	0.01	0.03	0.00	0.00
Assist Tug	0.02	0.00	0.01	0.00	0.00	0.00
Drill Rig	0.00	0.00	0.00	0.00	0.00	0.00
Military	0.00	0.00	0.00	0.00	0.00	0.00
HGB Total	23.88	1.37	4.39	9.51	0.00	0.66

The EPS3 processing streams for the commercial marine emissions are available for both [2012](#) and [2017](#) at [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/base\\_2012/offroad/marine/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/base_2012/offroad/marine/) and [ftp://amdaftp.tceq.texas.gov/pub/EI/2012\\_episodes/hgb\\_sip/future\\_2017/offroad/marine/](ftp://amdaftp.tceq.texas.gov/pub/EI/2012_episodes/hgb_sip/future_2017/offroad/marine/), respectively. The following pages contain graphical plots of the 2012 and 2017 commercial marine NO<sub>x</sub> emissions for the HGB area. These plots are respectively titled Figure 4-19: *2012 HGB Commercial Marine NO<sub>x</sub> Emissions Distribution* and Figure 4-20: *2017 HGB Commercial Marine NO<sub>x</sub> Emissions Distribution*. Since the diesel engines that power commercial marine vessels are not significant contributors of VOC emissions, only NO<sub>x</sub> plots are provided here.

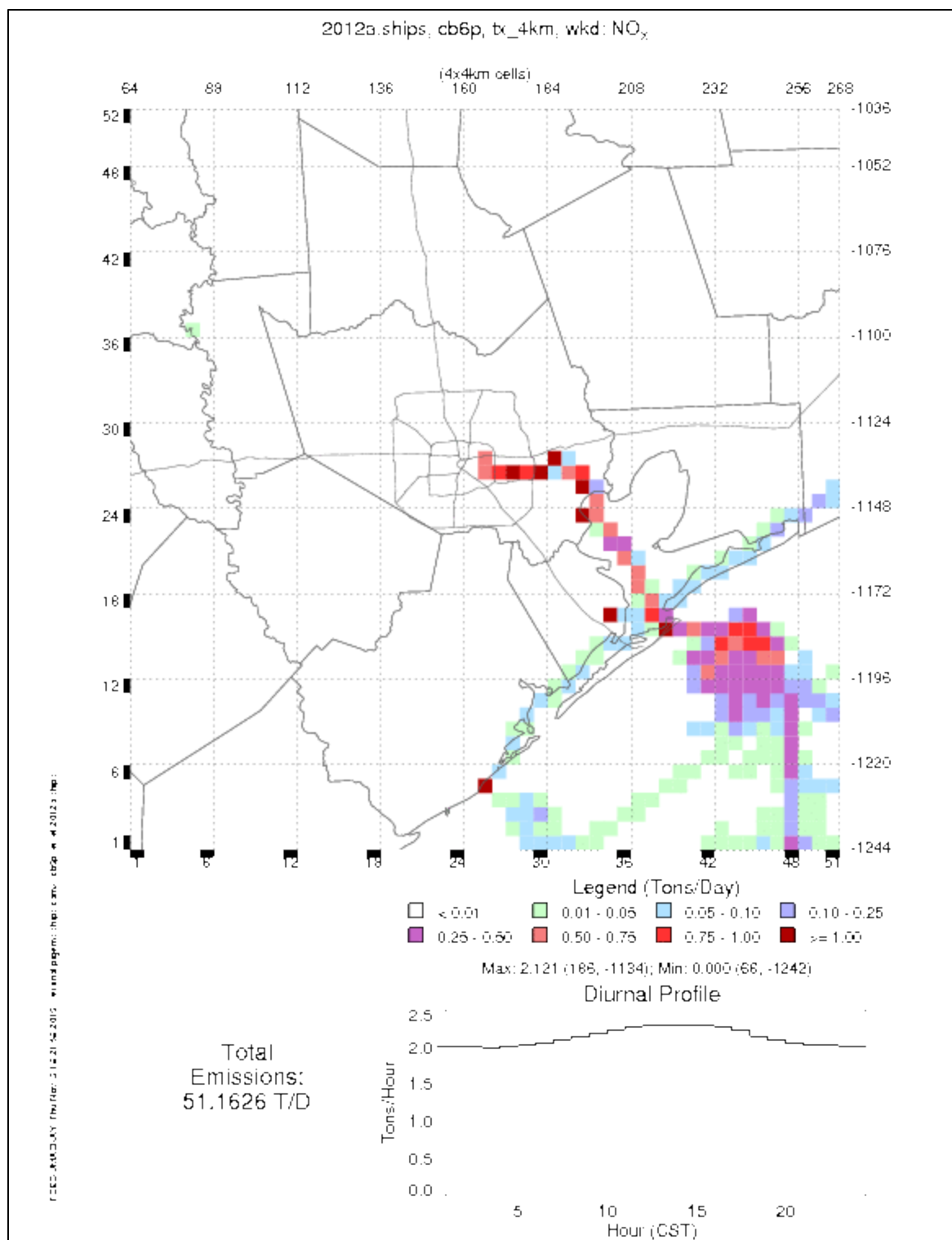


Figure 4-19: 2012 HGB Commercial Marine NO<sub>x</sub> Emissions Distribution

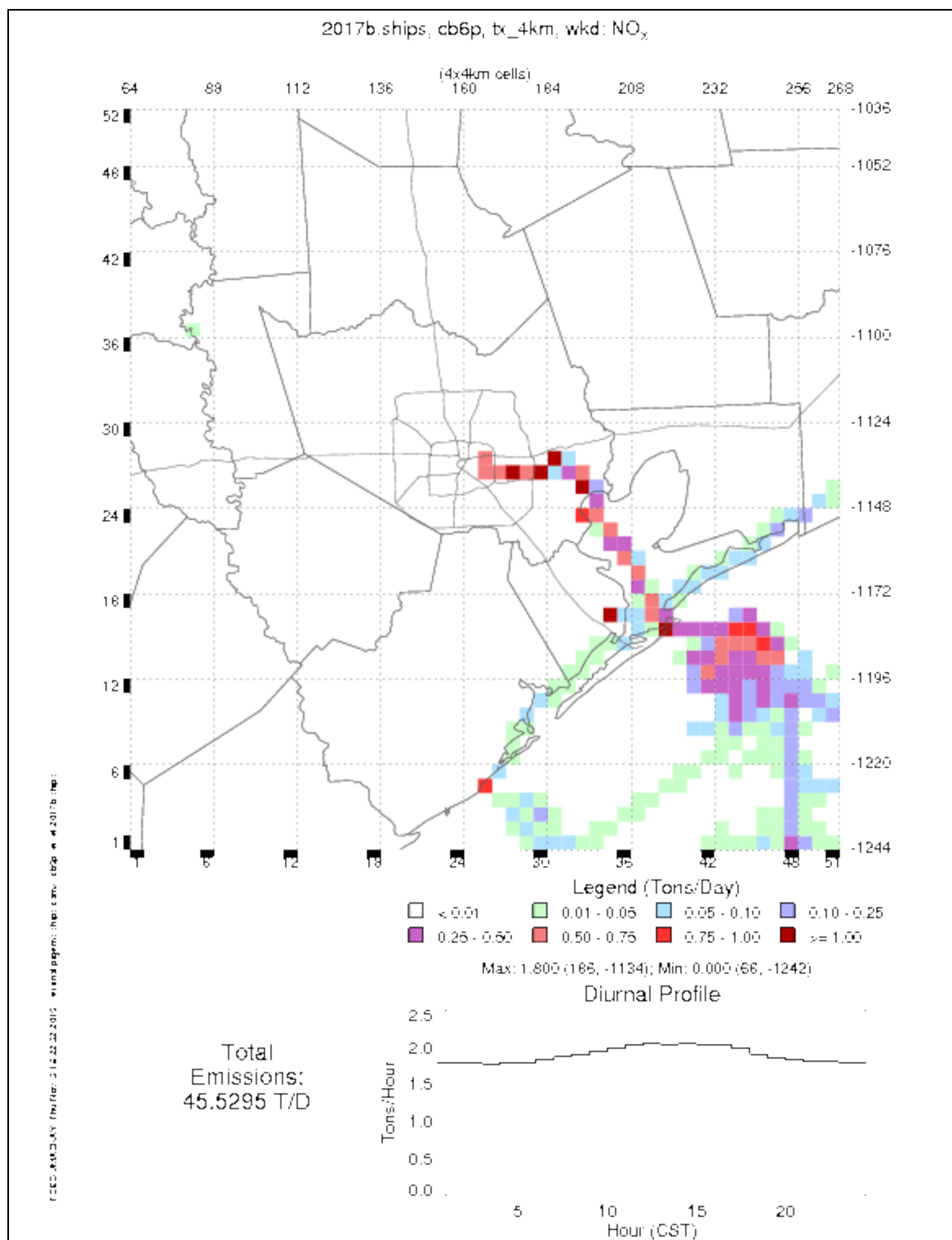


Figure 4-20: 2017 HGB Commercial Marine NO<sub>x</sub> Emissions Distribution

## CHAPTER 5: BIOGENIC MODELING EMISSIONS

The TCEQ used version 3.61 of the [Biogenic Emission Inventory System \(BEIS\)](#) ([Bash, et al., 2016](#)) within Sparse Matrix Operation Kernel Emissions (SMOKE) System version 3.7 (available at <https://www.cmascenter.org/smoke/>). BEIS inputs from SMOKE defaults include the emissions factors input file (\$GE\_DAT/b360fac\_beld4\_csv\_nlcd2006.txt) and the CB05 VOC speciation profiles (\$GE\_DAT/gspro.cmaq\_cb05\_soa.txt). The Biogenic Emission Landuse Database version 4.1 (BELD4.1) from EPA Modeling Platform 2011v6\_v3 at <https://www.epa.gov/air-emissions-modeling/2011-version-63-platform> was regridded with [Spatial Allocator](#) to create the grid-specific (rpo\_36km, tx\_12km, and tx\_4km) land-use input files. The Weather Research and Forecasting (WRF) version 3.7.1 results were processed with the Meteorology-Chemistry Interface Processor (MCIP) to generate the \$MET\_CRO\_2D, \$MET\_DOT\_3D, and \$GRID\_CRO\_2D meteorological inputs to BEIS.

### 5.1 BIOGENIC EMISSION SUMMARY

The BEIS model was run for each 2012 episode day. Since biogenic emissions are dependent upon the meteorological conditions on a given day, the same episode-specific emissions for the 2012 baseline were used in the 2017 future case modeling scenarios. HGB eight-county biogenic emission totals for one episode day per month are shown in Table 5-1: *Summary of Biogenic Emissions for Example 2012 Days*. The daily emission totals vary significantly depending on the meteorological inputs.

**Table 5-1: Summary of Biogenic Emissions for Example 2012 Days**

Episode Day	Isoprene (tpd)	Monoterpenes (tpd)	Nitrogen Oxide (tpd)	Total VOC (tpd)
5/15/2012	140.56	119.98	13.76	406.04
6/15/2012	397.99	232.64	16.48	938.27
7/15/2012	267.74	194.12	16.44	706.99
8/15/2012	411.78	258.39	16.87	1003.50
9/15/2012	187.10	168.12	14.65	557.76

Isoprene and other biogenic VOC emissions were plotted to determine the location of emissions matched known forested areas as shown in Figure 5-1: *Biogenic Isoprene Emissions on June 26, 2012 for the 4 km Domain*. The highest isoprene concentrations are in the eastern part of the domain where dense forests exist in Texas, Louisiana, and Arkansas. CAMx output concentrations of the same VOC for the same time period are also plotted to ensure concentrations follow expected emission magnitudes and observations. An example concentration plot of isoprene with observations plotted as colored circles for June 26, 2012 at 15:00 is displayed in Figure 5-2: *Modeled CAMx Isoprene Concentrations for June 26, 2012 at 15:00 CST*.

Biogenic EI, CB05, BEISv3.61, new\_beis361F\_2012\_wrf371, 20120626: ISOP

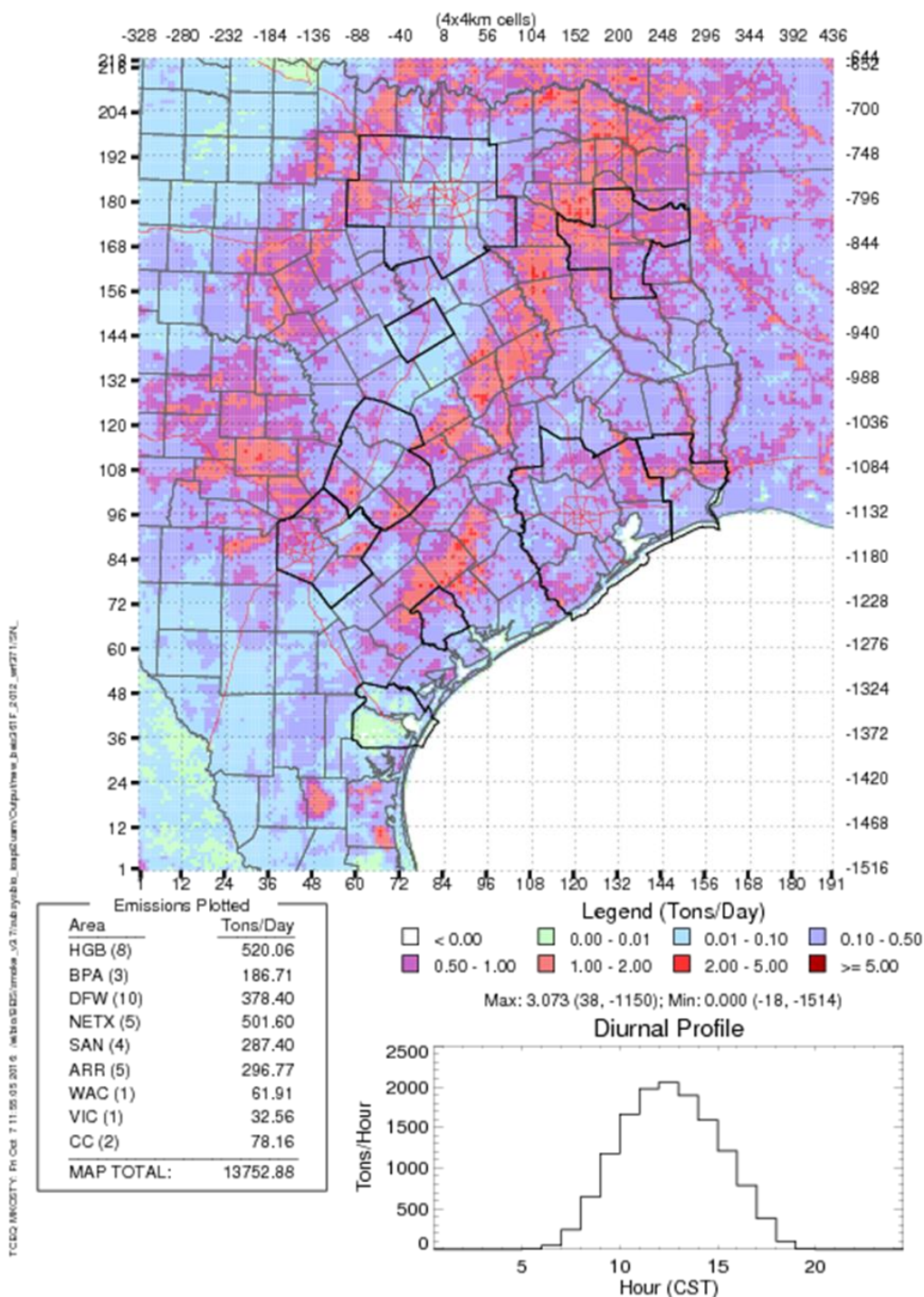
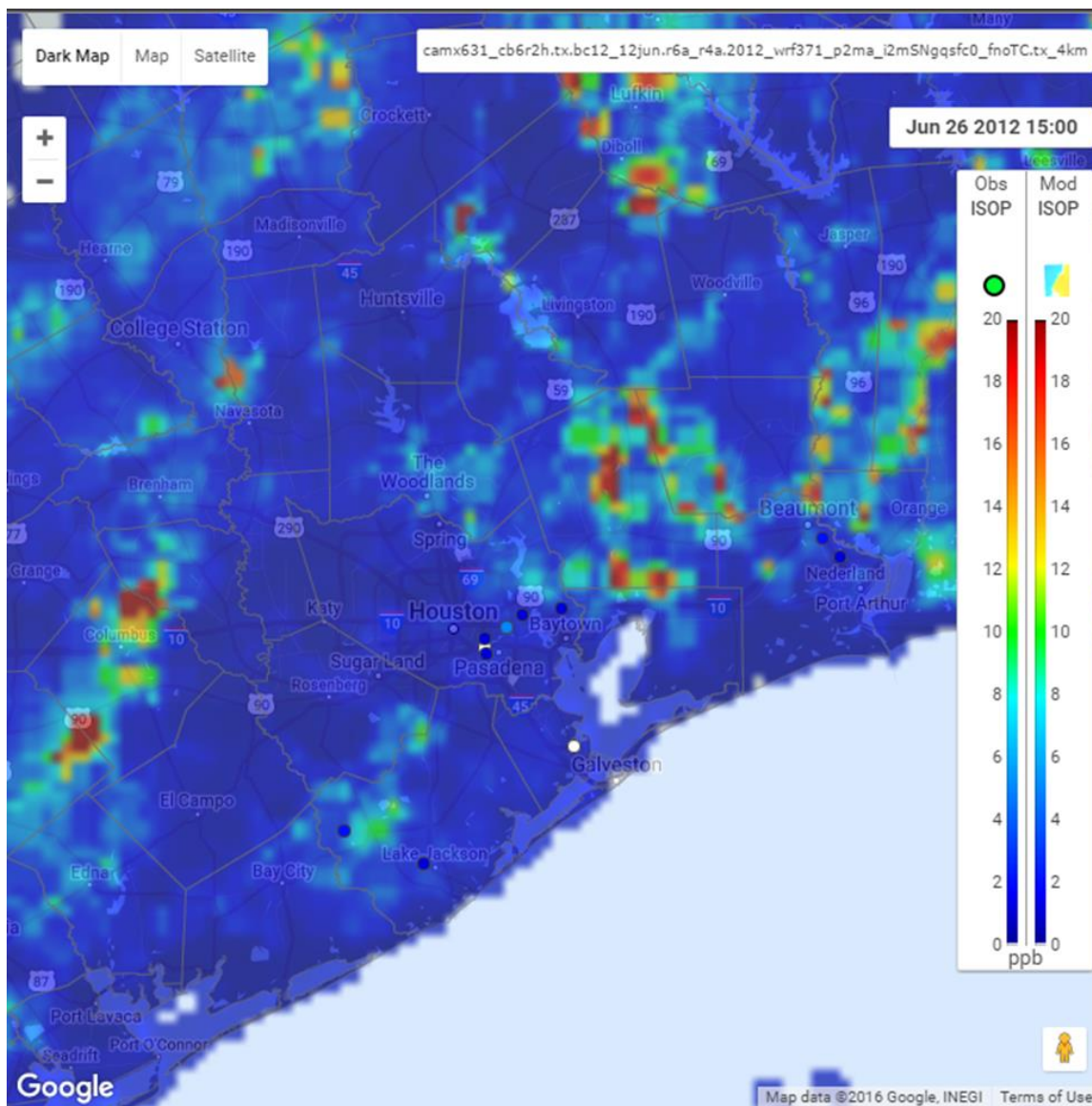


Figure 5-1: Biogenic Isoprene Emissions on June 26, 2012 for the 4 km Domain





**Figure 5-2: Modeled CAMx Isoprene Concentrations for June 26, 2012 at 15:00 CST**

## CHAPTER 6: REFERENCES

Bash, J., Baker, K., Beaver, M., 2016. Evaluation of improved land use and canopy representation in BEIS v3.61 with biogenic VOC measurements in California, *Geosci. Model Dev.*, 9, 2191–2207, 2016.

EPA, 2014a. Modeling Guidance for Demonstrating Attainment of Air Quality Goals for Ozone, PM<sub>2.5</sub>, and Regional Haze, [https://www3.epa.gov/ttn/scram/guidance/guide/Draft\\_O3-PM-RH\\_Modeling\\_Guidance-2014.pdf](https://www3.epa.gov/ttn/scram/guidance/guide/Draft_O3-PM-RH_Modeling_Guidance-2014.pdf), December 2014.

EPA, 2014b. SPECIATE Version 4.4 Database Development Documentation, February 2014,

[https://www3.epa.gov/ttn/chief/software/speciate/speciate\\_version4\\_4\\_finalreport.pdf](https://www3.epa.gov/ttn/chief/software/speciate/speciate_version4_4_finalreport.pdf).

EPA, 2016. EPA Petroleum Refinery National Case Results,  
<https://www.epa.gov/enforcement/petroleum-refinery-national-case-results>.

Ramboll Environ, 2015. User's Guide Emissions Processor, Version 3.22, July 2015,  
Ramboll Environ, Inc., Novato, CA.

Ramboll Environ, 2016. User's Guide Comprehensive Air Quality Model with Extensions (CAMx), Version 6.30, Ramboll Environ, Inc., April 2016,  
[http://www.camx.com/files/camxusersguide\\_v6-30.pdf](http://www.camx.com/files/camxusersguide_v6-30.pdf).

Thomas, Ron, Marvin Jones, Barry Exum, Dick Karp, Jim MacKay, 2010. Development of an Hourly Modeling Emissions Inventory from Several Sources of Regulatory Speciated Hourly Data for the Houston-Galveston-Brazoria Ozone Nonattainment Area, EPA-sponsored 17<sup>th</sup> Annual International Emission Inventory Conference, Portland, Oregon, June 2008. Poster Presentation,  
<http://www.epa.gov/ttn/chief/conference/ei17/poster/thomas.pdf>.

Yarwood, et al., 2012. Updates to the Carbon Bond Mechanism for Version 6 (CB6), CMAS conference, Oct. 2010.  
[https://www.mascenter.org/conference/2010/abstracts/emery\\_updates\\_carbon\\_2010.pdf](https://www.mascenter.org/conference/2010/abstracts/emery_updates_carbon_2010.pdf).